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1. MANAGEMENT

Gas Industry Expansion

Householding Customers Up 1.1 Million. *A.G.A. Monthly 42,* 17 (1960) May (3 pp.)

At the end of 1959 there were 20,162,000 householding customers of gas utilities in the U.S., compared to 19,003,000 on December 31, 1958. This gain of 1,159,000 represents an increase of 6.1% in the number of customers using gas for householding. A tabulated estimate of U.S. gas householding customers at the end of 1959 as well as the number of anticipated additional customers for 1960-1963 is given by states.

Export Decision Touches Off Gas Boom in Canada. L. O. Rowland. *World Petrol. 31,* 49 (1960) May (3 pp.)

Canadian federal government has approved recommendations by the National Energy Board for export of gas to the U.S. Five permits were granted to four major gas transmission companies; four of these permits must still obtain approval by the U.S. Federal Power Commission (expected as a formality). Permits granted were as follows: Trans-Canada Pipe Lines Ltd., export at Emerson, Manitoba, 204 MMCF/day, 20-year term; Trans-Canada Pipe Lines Ltd., export at Niagara Falls, Ontario, interruptible only, maximum 204 MMCF/day, limited to five years; Alberta and Southern Gas Co. Ltd., export at Kingsgate, B.C., about 459 MMCF/day, 25-year term; Westcoast Transmission Co. Ltd., export at Kingsgate, B.C., 152 MMCF/day, 20-year term; and Canadian Montana Pipeline Co., export at Coutts, Alta., 36 MMCF/day, 25-year term.

Gas Industry Management

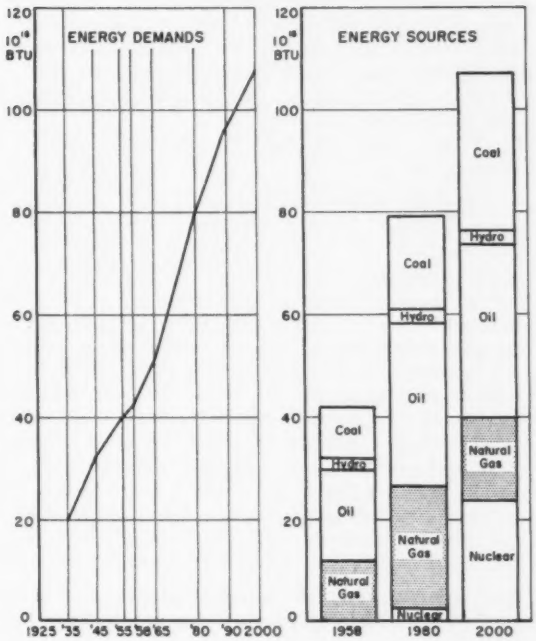
What Others Think. The Natural Gas Industry—Past and Present. *Public Util. Fortnightly 65,* 767 (1960) May 26 (4 pp.)

In a speech before the Federal Power Bar Association, Paul Kayser, then president of El Paso Natural Gas Company, outlined these three problems facing the industry: 1) the chaos brought about by the Supreme Court placing producers under utility regulation (the Phillips decision); 2) the fixing of a new and proper rate of return in view of the increase in cost of money, and 3) the necessity for industry to maintain itself in a competitive position in relation to other fuels. Articie summarizes highlights of speech.

How to Finance Oil and Gas Production. G. Ireton. *Oil Gas J. 58,* 165 (1960) May 9 (4 pp.)

Most oil men must continue to rely on lending agencies to finance most of their drilling and development since conditions in the oil industry, which would permit a quicker return on investment, cannot be expected to improve materially in the immediate future. Therefore, the producer must economize in every way that is practical and at the same time he must be careful not to get entangled in a cycle of continued borrowing, merely to create intangibles to avoid paying taxes. The basic elements of petroleum financing are discussed.

Energy Demands Climbing, Sources Shifting



(Adapted from *Energy Outlook—Quick Climb . . .* see abstract, p. 123)

Offshore Figures Tell Costly Story. E. McGhee. *Oil Gas J. 58,* 105 (1960) June 6 (3 pp.)

CATC company introduced its cost testimony into a case which is to determine the price companies get for gas produced offshore in an area near Cameron Parish, La. Figures show that the company pays two to five times more for its wells offshore than for similar wells onshore. And these wells are three to five times as costly to produce as dry land wells.

Underwater Completions May Improve Economics of Offshore Operations. D. H. Stormont. *Oil Gas J. 58,* 116 (1960) June 6 (4 pp.)

High cost of exploratory and development programs from platforms are slowing offshore operations. Floating drill barges have shown they can quickly and economically evaluate submerged oil structures. Carried out from floating barges, the subsea method of completion eliminates need for a large expenditure early in the life of a development. In the study made by Global Marine on the economics of a subsea development program, it was found that this method offered earlier income return, earlier payout, and greater net profits.

Using Management Science to Solve Control Problems. A. H. Schneyman. *Gas 36,* 43 (1960) June (11 pp.)

In an earlier article (see *Gas Abstracts 16,* 1), author suggested that management science—the blending of elements of management with the scientific method of

problem solving—can be used to solve managerial problems of planning, organizing, directing and controlling. Current article discusses effective use of this science to solve problems of attaining and maintaining control, and stresses that an understanding of the management element of "control" itself is required. A detailed case application of the scientific method in this area is included.

Appliances

Gas Industry Appliance Testing. F. E. Hodgdon. *Nat. Fire Protection Assoc. Quarterly 53,* 317 (1960) April (13 pp.)

Basic operations of the A.G.A. Laboratories, a nonprofit appliance testing and research organization, dedicated to the safety of gas appliance users, are described. Tests cited are typical of the comprehensive test procedures specified by the industry's national minimum standards for gas appliances and accessories to provide for safe operation, durable construction and satisfactory performance. From a review of standards it is apparent that gas appliances which display the Laboratories registered "Blue Star" Approval Seal are complying with the highest standards for safety. American Standard approval, listing, and installation requirements for gas appliances and accessories are given.

Gas Technology at the Spring Exhibition at Cologne. K. Zimmer. *Gas- u.-Wasserfach 101,* 468 (1960) May 6 (7 pp. German text.)

The Fair at Cologne showed that heating and cooking appliances are in a stage of dynamic development. Automation on auxiliary and safety devices has increased. Various models of fully automatic stoves, heating units, and gas washing machines are described. The French industry showed experiments to combine a cooking appliance, warm-water heater and space-heater into one unit.

Potential Appliance Sales: 57.4 Million in 1960-1964. *A.G.A. Monthly 42,* 21 (1960) May (5 pp.)

Bureau of Statistics of the A.G.A. estimates that the potential attainable market for gas appliances and equipment during 1960-1964 period aggregates 57.4 million units. Potential markets for individual appliances are: 13.3 million gas ranges, 18.0 million gas water heaters, 7.4 million pieces of gas central heating equipment, 10.1 million gas space heaters, 3.3 million gas floor and wall furnaces, 5.0 million gas dryers, and 0.3 million gas incinerators. Sales levels such as these will represent an investment of over $10.9 billion on the part of the American consumers.

Foreign Activities

Industrial Construction Costs in Latin America. E. A. Arroyave. *Cost Eng. 5,* 4 (1960) April (8 pp.)

Cost of heavy construction in Latin America differs from that in North America for three basic reasons: productivity of labor, social benefit structure and cost of materials. Estimates that do not consider these differences result in uneconomic planning. Some typical productivity rates and cost data obtained from a number of Colombian and Venezuelan projects are included. The following items are covered: buildings and construction items, process equipment, boilers, furnaces, generators, electrical work, insulation, painting and piping.

The Present and Future of the Oil and Gas Industries of the USSR. F. Trebin and I. Zlotnikov. *Independent Petrol. Assoc. Monthly 31,* 16 (1960) May (9 pp.)

The Congress of the Communist Party of the Soviet Union fixed in its seven-year plan target figures an output of 1.7 billion bbl (4.8 million bbl/day) of gas for 1965. This means that oil production is to go up 922 million bbl in the next seven years, or an average of 131 million bbl a year, and extraction and production of gas 4.5 billion MCF, or an average of 643 million MCF a year.

Gas Lights

Gas Lights—Installation and Service. O. B. Vogel. Paper DMC-60-25. (New York: American Gas Association, 1960, $.25); **Installing and Servicing Gas Lights.** *Gas Age 125,* 32 (1960) May 26 (2 pp.)

Gas industry is still talking about gas lights almost a century and a half after the first installations, because of a phenomenal renaissance of gas lighting in the U.S. From practically nothing, installation of gas lights rose to 250,000 units in 1958, just 50 years after gas lighting was all but killed by the incandescent bulb. In 1959 about 2 manufacturers entered the business, utility companies started sales campaigns, and even mail order houses started selling gas lamps.

Ignition

Resume of Pilot Ignition System Field Survey. J. C. Griffiths. Paper DMC-60-30. (New York: American Gas Association, 1960, $.25.)

Survey conducted as part of PAR research project DA-6-GU on "Ignition of Gases" for general utilization research was designed to obtain information on a national basis on ignition system performance and service complaints. Magnitude of ignition system service needs, actual causes for complaints and possible remedies were investigated. Areas of ignition research which could lead to design or application improvements to minimize such problems are indicated.

Olefins

New Uses Brighten Butylenes' Future. *Chem. Week 86,* 62 (1960) May 28 (9 pp.)

For butylenes in chemical manufacture, the midterm outlook—through 1965—shows no spectacular growth indications. Consumption in chemicals is expected to rise at a modest 5% to 7%/year rate. A number of other uses under development, however, could inject a more rapid growth. Among these are: polymers used in solid rocket fuels, production of an extender for natural rubber, startup of pilot plant production of a new high trans-polybutadiene rubber, and continuing

growth in requirements for copolymer resins. This year's consumption of butylenes is expected to be close to 3420 million lb and more up gradually to nearly 4000 million lb in 1965.

Petroleum

International Oil Controls Predicted. *Oil Gas J. 58,* 83 (1960) May 23 (2 pp.)

Some form of international control of the world's crude-oil surplus is predicted by Atlantic Refining Co. These comments followed closely an international proration proposal earlier from leading Arabs and Latin Americans. This proposal unveiled a plan for stabilizing world oil prices through market proration based on proved reserves.

Petrochemicals

The Production of Bulk Organic Chemicals. D. G. Smith. *Chem. & Ind.* 508 (1960) May 7 (8 pp.)

Production in Britain of petroleum-based organic chemicals has risen from a few thousand tons at the end of World War II to a half-million tons in 1958. Examples of growth are tabulated. The United Kingdom's production of petroleum-based chemicals, as a percentage of the total organic chemicals production, has risen from 20% in 1953 to 50% in 1959, and is expected to reach 70% in 1965. It is already 80% in U.S.A. Tabulated figures show that the feedstocks for chemicals are still less than 4% of petroleum consumption in Britain, and these figures are somewhat exaggerated because some of the chemical plants return gasoline to the petroleum market.

Pipeline Construction

Control of Construction by Contractors. B. F. Harris, Jr. Paper DMC-60-10. (New York: American Gas Association, 1960, $.25.); **Contract Construction and Its Control.** *Gas Age 125,* 31 (1960) May 12 (3 pp.)

"Peak shaving" is becoming customary in gas construction as well as in gas dispatching. Reasons are avoidance of problems of handling temporary labor, keeping overtime to a minimum and taking best advantage of specialized equipment and know-how. Control is best achieved by proper preparation of contracts and specifications.

Safety

Gas Industry Accident Facts. R. N. Papich. Paper CEP-60-13. (New York: American Gas Association, 1960, $.25.)

Gas utility and pipeline industry of U.S. in 1958 continued for the eleventh straight year to reduce its frequency rate from the 1947 post war peak of 21.86 injuries per million man hours worked to its lowest level since the A.G.A. began to compile accidents statistics in 1929. Reports from 516 gas utilities and pipelines, which represent 95.6% of the industry's employees, indicate a frequency rate of 8.07.

Underground Storage

Natural-Gas-Storage Capacity Jumps 12%. R. B. Bizal. *Oil Gas J. 58,* 89 (1960) May 30 (6 pp.)

Development of new underground storage capacity is keeping pace with the continued growth of the natural gas industry. Total storage capacity in the U.S. will climb to more than 3.03 trillion CF when the projects now under way or planned are completed. This is an increase of 12.2% over last year's figure of 2.7 trillion CF according to the survey on underground storage capacity.

The Underground Storage of Gas in the United States. Paper OP-60-1 (New York: American Gas Association, 1960, $.25)

American Gas Association's Committee on underground storage submitted its ninth annual report on statistics covering underground storage of gas in the United States for the year 1959. According to data received, the committee estimate for 1959 on ultimate reservoir capacity was reported to be 2,521 billion CF compared to 2,718 billion CF for 1958.

2. ENERGY SUPPLY AND ECONOMICS

Energy Sources

Energy Outlook—Quick Climb, Steady Shift in Sources. *Chem. Week 86,* 64 (1960) May 14 (15 pp.)

In 1958 energy consumption was 41.5 quadrillion Btu and by 1980 energy sources will be depleted at a 79.6 quadrillion Btu rate (see graph). By 2000, demands will have climbed to 107.1 quadrillion Btu. In the next 15-20 years, the burden of growth will be borne by oil and natural gas. Hydroelectric capacity will be steadily increased, but it will gradually lose some of its share of the total energy market. Coal will continue to hold its own. Sometime after 1975, nuclear energy will make itself felt. After 1980, petroleum sources will start to diminish in relative importance until the year 2000, when nuclear energy and coal will together supply more than half the energy consumed in the U.S.

What May Be Ahead in Power Production. G. B. Warren. *Mech. Eng. 82,* 61 (1960) May (5 pp.)

It is believed that the large steam-turbine fossil-fuel-fired steam-boiler plant will be used to meet the bulk of electric power needs for a minimum of 20 more years. Water power plants will be developed as years go on, but evidence seems to indicate that they will supply a decreasing percentage of the total power, certainly not more than 20% of the new growth ahead. Fission-fuel nuclear power plants will take an increasing percentage of the load, but supporters of these projects would not expect to have more than 60,000,000 kw installed in nuclear power plants by 1979, which would be only 10% of the total.

The Technological Approach to Fuel and Power Problems. W. K. Hutchison. *Gas J. 302,* 103 (1960) April 20

(5 pp.); **Fuel and Power: A Technological Approach.** W. K. Hutchison. *Chem. & Ind.* 455 (1960) April 23 (5 pp.)

Large centralized gas making units give increasing importance to cost reductions in fuel transmission systems, and the author shows that transmission charges per therm are lower for gas than for electricity. Gas made at high pressure is cheaper than compressed gas, so provision of extensive underground storage reservoirs near centers of consumption should combine these gains with those from an increased manufacturing load factor. It is suggested that the long-term interests of economy and efficiency in energy supply can best be served by allowing each supplier to choose from among materials available within the national economy, those best suited to the special technologies at his command.

Fuel Technology in Canada. A. Ignatieff. *J. Inst. Fuel. 33,* 223 (1960) May (9 pp.)

Since the end of World War II, the Canadian fuel economy has been characterized by an upsurge in the production and use of fluid fuels (i.e. oil and gas). Up to 1959 an increasing demand indicated that coal was still participating in the economic expansion of the country. However, during the last four years traditional markets have shrunk, and few alternative outlets can be foreseen in the immediate future.

Natural Gas

How Natural Gas Moved in 1958. I. Putnam. *Oil Gas J. 58,* 180 (1960) May 9 (3 pp.)

Chart showing the general movement of natural gas through various channels of regulation into its final use during 1958 was prepared from data gathered and published by the Federal Power Commission, the U.S. Bureau of Mines and the American Gas Association.

Liquefied Methane

Construction, Operating Costs of LPG Storage. W. L. Nelson. *Oil Gas J. 58,* 142 (1960) May 9

Recent cost data and references on LPG liquid methane storage are presented.

Petroleum

What the Crude Market Is Up Against. *Oil Gas J. 58,* 61 (1960) May 23 (3 pp.)

Domestic crude market has been considerably diminished by the competition of natural gas, imports and the loss of exports. Imports were leveled off by government restrictions and natural-gas liquids, a byproduct of gas production also entered the competition with heating oils, motor fuels and refinery yields as a blending or charging stock. A number of illustrations show the impact of gas on the crude market.

Solar Energy

Solar Energy: Heat Source for Tomorrow's Heat Pump? E. B. Penrod and K. V. Prasanna. *Heating Piping & Air Conditioning 32,* 118 (1960) May (9 pp.)

Solar energy, the one income energy that is abundantly available, has great potential for use with the heat pump. The authors give information concerning the merits of solar-earth heat pumps for space heating. It is hoped that in the near future considerable attention will be given to the development of a heat pump system of the proposed type. The basic data obtained will lay the foundation for better and more economical designs.

Tar Sands

Seek Okay for Big Tar Sands Project. *Petrol. Week 10,* 25 (1960) June 3 (2 pp.)

Alberta Oil & Gas Conservation Board has met to consider a $110 million proposal for commercial development of Athabasca tar sands by Great Canadian Oil Sands Ltd. In its application, Great Canadian Oil Sands predicts a production of 31,500 bbl/day of 24-gravity crude, at an average cost of $1.82/bbl. The conservation board was empowered to decide what amount of oil may be removed from the tar sands without upsetting the market for other Alberta oil.

Thermoelectricity

New Methods of Generating Electricity from Gas Sources. C. G. Von Fredersdorff. Paper CEP-60-12. (New York: American Gas Association, 1960, $.25.)

Increased attention has been given recently to direct conversion of methods of generating electricity. Prime objective is development of a direct route for production of electrical energy from heat energy. Three direct conversion techniques are explored in this paper. The thermoelectric generator relies on the thermocouple effect between dissimilar metals. The thermionic converter operates by virture of evaporation of electrons from a heated surface and the magnetohydrodynamic generator depends on the action of a magnetic field on a flowing ionized gas.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

Development and Field Use of a High-Frequency Gas-Operated Rotary-Percussion Drilling Tool. G. C. Howard, R. P. Vincent and L. B. Wilder. *J. Petrol. Tech. 12,* 20 (1960) May (7 pp.)

A successful air or gas-operated percussion tool was developed and used in drilling nine wells. Penetration rates with the percussion tool in these wells averaged 2.5 times faster than those obtained with rotary gas drilling and approximately 5 times greater than rotary mud drilling. Laboratory and field tests indicate that bit footages with rotary-percussion drilling have averaged 1.3 to 4 times those observed with conventional air rotary. Evaluation of laboratory drilling tests and field results shows that, where air drilling is economical, the percussion tool should be used to further decrease well costs.

Effect of Bit Weight on Drilling Rate. P. L. Moore and C. Gatlin. *Oil Gas J. 58,* 90 (1960) May 23 (4 pp.)

Authors try to write equations which show the variation of weight on bit over the length of the bit run in order to minimize cost. Previous work is examined to establish the variation of instantaneous drilling rate with bit weight. "Instantaneous" drilling rates are only discussed and factors such as bearing and tooth wear are omitted.

Make Your Drillstem Test a Success. G. E. Wilson and J. R. Holmes. *Petrol. Eng. (Drilling and Producing) 32,* B-40 (1960) May (2 pp.)

Many drillstem tests, important to primary formation evaluation, are unsuccessful simply because the well has not been properly conditioned prior to the test. Good conditioning means fewer misruns, better test results, greater safety factor, eliminating chances of blowout, lost circulation and stuck drill pipe. The causes of misruns are described and proper preparations are recommended.

Water-Shutoff Techniques. C. K. Sufall. *Producers Monthly 24,* 26 (1960) May (3 pp.)

Water-shutoff techniques have been generally accepted procedures for air and gas drilling if economic gain could be realized. Although the methods are still in primary stages, it can be concluded that the less fractured or open the permeability, the better is the chance for complete water shutoff. Squeeze pressures must be maintained as low as possible to avoid fracturing the water-bearing formation. Initial results of water shutoff indicate that better results are attained from materials that gel or set after entering the permeable section. Finally, most important is a study of the characteristics of the formation to be penetrated, a knowledge of the tools and materials available, and a preparedness to cope with the situation when it arises.

World's Deepest Ultra-Slim Hole is Ultra Hot. F. Newlin and J. E. Kastrop. *Petrol. Eng. (Drilling and Producing) 32,* B-19 (1960) May (8 pp.)

An unusual well located 35 miles northeast of Laredo, Texas, was drilled, with a 3¾-in. bit, to a total depth of 20,603 ft where temperatures measured were 465°F. A well-engineered mud program, good drilling equipment, experienced personnel and particularly good hydraulics were some of the factors attributed to the drilling success.

Drilling Muds

Planned Mud Program Cuts Drilling Costs. K. D. Tanner and G. B. Gray. *Oil Gas J. 58,* 172 (1960) May 16 (4 pp.)

Texas Gulf Coast operators now have the opportunity to tailor their mud program to take advantage of new mud materials and to minimize well trouble. Where stuck pipe or casing is a possibility, inhibited muds, oil-wetting agents, and lubricants are often used to reduce sticking tendency. Many operators now avoid loss by careful control of the flow properties. Lowering and closely controlling the mud density, thereby cutting the difference between mud and formation pressures, has definitely reduced loss. On several "hot" wells, the mud type has been changed progressively as the hole deepens and temperature rises. Result is lower overall mud cost and fewer drilling problems.

Second Annual Directory of Muds and Additives. *Drilling 21,* 48 (1960) May (5 pp.)

Functional classification of names, descriptions and suppliers of more than 300 products available for use in the drilling rig's circulatory system is given. Included are: clay materials, defoamers, dispersants, flocculants, control agents, invert emulsions, foaming agents, surfactants.

Geology

Estimation of Relative Maximum Depths of Burial. G. D. Hobson. *J. Inst. Petrol. 46,* 89 (1960) March (2 pp.)

Shales and clays are subject to compaction on burial; their porosity diminishes as the depth of burial increases, and correspondingly the bulk density increases. This change in density, which must be linked with changes in elasticity, is associated with a change in velocity with which seismic impulses are transmitted through the rocks. Depth/load relationships as well as temperature gradient depend on the nature of the rocks and their degree of compaction. These points must be taken into consideration when making deductions from estimates.

Logging

New Developments in Induction and Sonic Logging. M. P. Tixier, R. P. Alger and D. R. Tanguy. *J. Petrol. Tech. 12,* 79 (1960) May (9 pp.)

A new induction sonde was developed recently for cases of deep invasion. It has nearly the same vertical resolution as the present sonde so that thin beds are defined as accurately as before. Characteristics of the new tool are described, corresponding interpretation charts are given and field examples are discussed. Design of the sonic logging tool was modified to improve calibration and reliability. The fact that porosity can be accurately recorded by means of the sonic log has promoted new interpretation, procedures for saturation estimation, wherein the data concerning various permeable beds in a given well are correlated.

Offshore Operations

Great Lakes Search Focuses on Eastern End of Lake Erie. B. C. Donnan. *Oil Gas J. 58,* 102 (1960) June 6 (3 pp.)

One of the busiest drilling seasons is expected this year on Lake Erie with estimates of a 15% increase in activity. Proved reserves increased 13 billion CF with a cash value of about 4.5 million dollars. Daily potential flow of gas last year from new wells on Lake Erie was 28.7 million CF.

Storm Warnings Are Coming Down for Gulf of Mexico Offshore Drillers. E. McGhee. *Oil Gas J. 58,* 99 (1960) June 6 (3 pp.)

Economic climate is more pleasant for companies operating in the Gulf Coast than it has been for the past 3 years. These companies have recently bid record sums for unproved offshore acreage, drilled new wells this year at a near record pace and increased demand for offshore rigs.

World-Wide Offshore Areas Begin Yielding Their Promised Riches. P. Swain. *Oil Gas J. 58,* 93 (1960) June 6 (6 pp.)

Gulf of Mexico was the most attractive spot for marine exploration and drilling in recent years, but it is beginning to share the limelight with other waters across the globe. The Persian Gulf, the Sea of Japan and the Gulf of Paria between Venezuela and Trinidad are the offshore hot spots claiming distinction outside the U.S. Shell is making active preparations to spud a well in the North Sea and a half-dozen continental shelf areas are churned by drillers.

Permeability

Flow Through Porous Media. A. E. Scheidegger. *Appl. Mech. Rev. 13,* 313 (1960) May (6 pp.)

Some of the highlights of physics of flow through porous media are reviewed. The author starts with a definition of porous media and discusses the law of Darcy, which is mostly used in connection with engineering applications. Limitations of Darcy's law and theoretical models of porous media are discussed and a brief account is given of displacement processes.

Reservoir Engineering

Case Histories of Analyses of Characteristics of Reservoir Rock from Drill-Stem Tests. C. B. Ammann. *J. Petrol. Tech. 12,* 27 (1960) May (10 pp.)

Case histories presented of analyses of characteristics of reservoir rock from drill-stem tests illustrate that drill-stem test analysis may be used to evaluate a formation within the vicinity of a wellbore. Examples presented show that an analysis will determine to a practical degree such properties as true pressures and potentiometric surfaces, transmissibilities, actual and *in situ* producing capacities and permeabilities, productivity index, damage ratio, production rates, distance to any apparent barrier interferences near the wellbore and approximate drainage radius during a test.

Computer Programs for Tarner Calculations of Gas-Drive Oil Recovery by Analytical or Iterative Method. R. V. Higgins and A. J. Leighton. *U.S. Bur. Mines Rep. Invest. 5608* (Pittsburgh: The Bureau, 1960.)

In a recent report (see *Gas Abstracts 16,* 78), the authors presented a rapid method of calculating, by means of a desk calculator, the future performance of oil reservoirs in which the motivating agent was gas. Accuracy of the method was tested by data obtained from an electronic computer. Because of accuracy obtained for the limited number of calculations performed, considerable interest has been expressed in the electronic program used to obtain the comparative data by analytical solution. Computer procedures for the analytical solution are presented in this report.

Downhole Flowmeter Pinpoints Flow. *Petrol. Eng. (Drilling and Producing) 32,* B-102 (1960) May (2 pp.)

Flowmeter described is a long tubular instrument which looks like a slightly overweight javelin with a rubber bladder impaled about midway along its shaft. It is designed to be lowered into a well on a wire line and to measure accurately, in intervals of a foot or two, the flow of liquids or gas at any level. It has proved many times to be an excellent diagnostic tool in the treatment of ailing producing wells. It was, however, predicted that the flowmeter's most important role will be in providing needed reservoir information through routine flow surveys.

The Electrical Resistivity of Preferentially Water-Wet and Preferentially Oil-Wet Carbonate Rock. S. A. Sweeney and H. Y. Jennings, Jr. *Producers Monthly 24,* 29 (1960) May (4 pp.)

Resistivity measurements were made on porous carbonate rock which contained varying amounts of electrolyte and aliphatic hydrocarbon. The porous rock was treated so as to make the carbonate surface preferentially water-wet and then preferentially oil-wet. Resistivity data, expressed in terms of formation factor and resistivity index, on preferentially water-wet samples were considerably different from the data on oil-wet samples. The results are discussed in terms of the effect of changes in wettability on porosity and water saturation values derived from electric well logs.

Secondary Recovery

East Texas' First Fire Flood is Successful. P. D. White and J. T. Moss. *Oil Gas J. 58,* 102 (1960) May 30 (3 pp.)

Data collected from the Carrizo-Wilcox formation in East Texas is valuable information for operators considering thermal recovery projects of the *in situ* combustion type. Efficiency in the test is higher than any previously reported in the literature. There is no evidence of excessive corrosion. Sand control is a problem at the greatly accelerated production rate. Outlook for a commercially successful, full-scale project in the near future looks promising.

Reverse Combustion—A New Oil Recovery Technique. R. H. Perry, D. W. Green and J. M. Campbell. *J. Petrol. Tech. 12,* 11 (1960) May (2 pp.)

In situ combustion and the subject of reverse combustion are introduced. Both forward and reverse combustion utilize as fuel the residual coke from the in-place oil. Difference between techniques is whether the flame front and material flow are in the same direction (forward combustion) or in opposite directions (reverse combustion).

4. GAS CONDITIONING AND LPG RECOVERY

Dehydration

Britain's First Dehydration by Refrigeration Plant. *Gas J. 302,* 262 (1960) May 18 (2 pp.); **Drying Town Gas by**

Refrigeration at Preston. *Gas T. 94,* 26 (1960) May (2 pp.); **Town Gas Dried by Refrigeration.** *Gas World 151,* 844 (1960) May 28.

Recently completed gas drying plant of the North Western Gas Board near Preston is the first plant of its kind employing refrigeration for drying town gas. It is designed to handle 5 million CF of gas a day at pressures of 10 to 16 psig. The plant will chill the boosted gas to a dew point of 37°F at all times of the year. The plant is also designed to dry local low pressure supplies as a secondary process.

Dust Removal

Electrostatic Precipitators. H. J. White and W. A. Baxter, Jr. *Mech. Eng. 82,* 54 (1960) May (3 pp.)

Two designs of collecting plates previously developed for the collection of dry dispersoids—made of expanded metal and of perforated metal—are described. Electrical performance of the surfaces was investigated. In view of the electrical superiority of the solid sheets and the aerodynamic superiority of the described baffles, prototype collecting plates were constructed and their performance compared with expanded metal plate designs. It was concluded that the solid plate is superior in every laboratory-measured characteristic to the expanded metal plate.

Hydrogen Sulfide Removal

Klonne System of High Pressure Purification. *Gas World 151,* 799 (1960) May 21 (2 pp.)

Klonne system dispenses with a central tube and attains distribution of gas by three semicircular channels located on the periphery of the trays. These are simultaneously used as a support and thus achieve a much more favorable pressure distribution and sealing of the trays against each other. Consequently, in this arrangement the trays with enriched material can be automatically discharged.

Method of Removing Hydrogen Sulphide from Gaseous Mixtures by Means of Arsenical Solutions. G. Giammarco (assigned to Vetrocoke S. p. A., Turin, Italy) U.S. 2,937,071 (1960) May 17.

Invention relates to an improvement in eliminating hydrogen sulfide from gaseous mixtures by scrubbing with arsenic solutions. The fouled solution is oxidized to convert arsenite back to arsenate with oxygen above 50°C and in a pH level of at least 8, while maintaining a concentration of free arsenate in excess of three moles for each mole of thioarsenate present. The oxidizing step can be performed in the presence of catalysts such as hydroquinone, pyrocatechin, pyrogallol, etc.

New Solvent Lowers Gas-Treating Cost. *Chem. Eng. 67,* 46 (1960) May 30 (2 pp.)

El Paso Natural Gas Co. began the construction of a $3-million Fluor process facility which will feed on 220 MMCF/day of natural gas containing 50% CO_2 and will yield 100 MMCF/day of high purity product. The installation is based on a new, patented solvent for absorbing CO_2, followed by a series of flashing steps to release dissolved materials. This plant is one element in the expansion which El Paso Natural Gas Co. has planned in Texas which is to include a gas gathering system and a 20-in. 51 miles transmission pipeline.

Recovery of Sulfur by Separation from Hydrocarbon Gases. *Rev. Gen. du Gaz 82,* 66 (1960) March-April (9 pp. French text.)

Review of a publication, "Shell Chemicals", by the Belgian Shell Co. is presented. First a study of sources, consumption and sulfur recovery statistics is given, covering world and national data. A special chapter is devoted to sulfur recovery from petroleum. Hydrogen sulfide recovery by liquid and dry (Claus) methods are discussed and a comparison of the economies of several processes is given.

5. NATURAL GAS TRANSMISSION

Automation

Computers, $'s and Pipelines. E. E. Richardson and A. C. Winter. Paper GSTS-60-18. (New York: American Gas Association, 1960, $.25.); **Computers, Dollars and Pipelines.** *Pipeline News 32,* 32 (1960) May (7 pp.)

Variable load factor pipeline requires extremely complicated control of compressor equipment. Computations required to provide adequate control are lengthy and difficult. A computer coordinated supervisory control system is described which performs all the necessary computations, control functions, data logging and safety surveillance for such a system with minimum supervision from the system dispatcher. Background data and helpful assistance for the study was provided by Texas Eastern Transmission Corp.

Internal Control of Automatic Compressor Stations. R. E. Kelly. Paper GSTS-60-16. (New York: American Gas Association, 1960, $.25.); **Internal Control of Automatic Compressor Stations.** *Gas Age 125,* 27 (1960) May 12 (5 pp.)

Today's trend toward automation is explained by the author in the sense of using a computer instead of personnel for obtaining, processing, storing and comparing information from distant sources as well as making decisions in directing operations. How this type of automation can be used for internal control of field and compressor stations is outlined.

Compressors

Calculation of Reciprocating Compressor Performance Data. R. L. Ridings. *Petrol. Eng. (Management) 32,* D-26 (1960) May (4 pp.)

Automatic digital computer provides information on relationships between suction and discharge pressures, compressor volumetric capacity and engine load. The computations involved were programmed for an IBM 650. The method developed eliminates the necessity for the output of intermediate results and the drawing

and interpretation of curves plotted from these intermediate results.

Operating Characteristics of Engine-Driven Centrifugal Compressors. C. Taylor. *Gas 36,* 95 (1960) June (11 pp.)

In 1960, Transwestern Pipeline, now under construction, will place into operation the first all centrifugal compressor pipeline, and all these compressors will be powered by reciprocating gas engines. With completion of this system, the natural gas industry will have a new pattern that will influence future compressor stations and pipeline designs. The year 1960 will also record the introduction to the gas industry of two new large reciprocating engines, specifically designed to drive the centrifugal compressor.

Operating Curves Developed for Natural Gas Compressors. H. B. Martch, Jr. and J. T. Watzke. *Petrol. Eng. (Management) 32,* D-22 (1960) May (4 pp.)

Efficient operation of natural gas pipeline compressor units require that the prime mover be operated as closely to its rated load as possible. This can be accomplished if compressor load characteristics are available. The development of these characteristics is a time-consuming task. The authors show how a computer can relieve the engineer of this burden for reciprocating and centrifugal compressors.

Fluid Flow

Simplified Pipeline-Flow Formula. W. L. Ducker. *Oil Gas J. 58,* 94 (1960) May 23 (7 pp.)

Suitable for routine algebraic solution, this formula is the result of integration of a compressibility correction factor along with other variables in the basic differential equation. Simplification is possible because only temperatures and pressures common to pipeline operating conditions are considered. Values of the compressibility factor, Z, at the 1.50 reduced pressure isobar are given and its use in the flow formula explained.

Gas Turbines

Development of a Three-Stage Liquid-Cooled Gas Turbine. S. Alpert, R. E. Grey and W. O. Flaschar. *J. Eng. Power 82,* 1 (1960) Jan. (9 pp.)

Three-stage gas turbine was designed to operate at 1750°F inlet temperature with nonstrategic, low-alloy components. The rotor blades were cooled with water in a closed system and the stator was cooled with air. A practical design for the rotor was evolved and tested. Heat transfer data correlated well with expected values.

Tapline's Troubles with Turbines. R. C. Hill, R. H. Hubbell and H. L. Krapp. *Oil Gas J. 58,* 77 (1960) May 30 (4 pp.)

Efforts of Trans-Arabian Pipe Line Co. have succeeded in meeting pumping requirements on the line from Saudi Arabian fields to the Mediterranean. Many problems caused severe maintenance conditions during initial period of operation, but the basic concept of remotely controlled gas turbine pumping units is believed sound. Problems affecting maintenance of power capability were severe. Individual units have deteriorated as much as 50% of rating during very short service periods. Units have to be modified to overcome problems of handling crude oil in desert environment.

Two-Shaft or Single-Shaft Gas Turbines. J. L. Mangan and T. C. Heard. *Oil Gas J. 58,* 107 (1960) May 23 (7 pp.)

Within the past year, several single-shaft combustion gas turbines have started operation on gas pipelines. Until this time, and except for an early small-size unit, all gas turbines on pipelines were of the two-shaft type. Operating considerations in the selection of single- or two-shaft gas turbines for driving centrifugal compressors on a gas pipeline are discussed. To simplify any comparisons, it is assumed that the rated horsepower and output speeds and thermal efficiencies at the rating point are the same for both units.

Metering

Methods for Improving Accuracy of Present Day Measurement. W. M. Moore. Paper GSTS-60-12. (New York: American Gas Association, 1960, $.25.)

Article describes a treatment of error problems encountered in measurement operations with considerable discussion of automation of chart handling. Two devices are described which would automatically perform chart calculating processes now performed manually. An optical chart integrator is described which reads and computes the extension of a chart in approximately 15 sec. Temperature, pressure and gravity charts are averaged on another machine that reduces the processing time approximately five fold.

Pipeline Construction

Developments in Pipeline Construction. W. H. G. Roach. *Gas World 151,* 768 (1960) May 14 (2 pp.)

Problems and developments of pipeline construction in England are discussed briefly.

High-Accuracy Control Systems for Submarine Pipelines. R. J. Brown. *Oil Gas J. 58,* 108 (1960) June 6 (5 pp.)

Control systems using the telurometer for offshore operations and survey instruments for river crossings fulfill high accuracy requirements for locating submarine lines during installation. Collins Construction Co. uses these systems, basing them on preprogramed instant plotting sheets. This type of horizontal control lends itself well to the procedure of pulling pipe by the friction-transposition method.

Higher Yield Strength Line Pipe. *Pipeline News 32,* 38 (1960) May (2 pp.)

Great Lakes Steel Co. is offering a higher yield strength steel—up to 60,000 psi minimum—for fabrication into line pipe. The product, bearing the trade name GLX-W, is a new family of high strength, fine grained, semi-killed mild carbon steels, treated with varying amounts of columbium.

How About "Thin-Wall" Pipe? E. Sterrett. *Pipeline News 32,* 25 (1960) May (6 pp.)

Continental Pipe Line Co.'s completion of a 157 mile, 6⅝-in. products pipeline from Artesia, N. Mex., to El Paso, Texas, is among the first to use "thin-wall" pipe in a cross-country transmission system under pressures normally considered safe only in conventional API standard pipe.

The Stopple Plugging Machine and Its Use in Pipe Systems. E. O. S. Owens. Paper GSTS-60-10. (New York: American Gas Association, 1960, $.25.)

Stopples could be described as temporary pipeline valves, which can be inserted and removed at any point and at any time regardless of operating conditions. A split tee fitting is welded on the carrier pipe which meets all of the requirements of present welding techniques on modern, prestressed, high tensile pipe. Because of the inherent safety, proven dependability and simplicity, this device is also used in plant piping systems.

Submergible Caisson for Underwater Gas Line Hot Taps. B. Quarles. *Pipeline News 32,* 30 (1960) May (2 pp.)

Submergible pipeline caisson, recently developed and proven on two "hot-taps" in inland Louisiana waters, adds more knowledge to the search for economical access to submerged pipelines. Refinements and innovations in design, however, make the equipment adaptable to pipe through 30-in. in diameter; extend working limits of basic unit to 25 ft water depth; and make possible "hot tap" valve settings of up to 12-in. size and installation of risers of up to 24-in. in diameter.

Pipeline Operations

Pipeline Purging. C. McClure. Paper GSTS-60-7. (New York: American Gas Association, 1960, $.25.); **Pipeline Purging.** *Gas Age 125,* 35 (1960) May 26 (3 pp.)

Various methods used in pipeline purging are reviewed including one which reduces the amount of waste gas.

Piping

High Density Polyethylene Pipe for Low Pressure Gas Gathering Systems. L. B. Croley. *Pipeline News 32,* 42 (1960) May (6 pp.)

Field experience together with installation cost studies show that high density polyethylene pipe can satisfactorily be used for low pressure gathering systems at less expense than steel pipe. Experience, data and physical properties presented refer to Marlex TR-212 which is especially tailored for pressure piping.

Static Testing High-Pressure Piping Components. T. G. Moore and E. J. Opersteny. *J. Eng. Ind. 82,* 15 (1960) Feb. (8 pp.)

High-pressure piping systems for service in the 20,000 to 40,000 psi range was tested. The behavior of pressure tested tubing systems was followed by means of resistance wire strain gages mounted on the exterior surface. The pressure at which a tube wall becomes fully plastic was graphically determined. Allowable working pressure of a tube was evaluated by applying a safety factor. The behavior of tubing bends and fittings was tested by comparing it with the tube with which they were used.

Telemetering

How Telecontrol Can Assist Dispatching. C. G. Fuller, Jr. Paper GSTS-60-2. (New York: American Gas Association, 1960, $.25.); **How Telecontrol Can Assist Pipeline Gas Dispatching.** *Gas Age 125,* 25 (1960) May 12 (2 pp.)

Telecontrol is best described as the combination of all modern control devices such as radio, wireline, microwave, telemetering, telephone and remote or supervisory control of valves, compressor stations and other installations. These elements by which present gas dispatching organizations can operate with a minimum of changes in procedure are briefly discussed.

Telemetering for Billing. T. G. Humphreys, Jr. Paper GSTS-60-11. (New York: American Gas Association, 1960, $.25.); **Telemetering for Billing.** *Gas Age 125,* 21 (1960) May 26 (3 pp.)

Following three areas of gas measurement may profitably employ telemetering techniques: city gate stations, interchange measurement stations and large industrial or commercial stations, where daily or hourly readings are needed. The author discusses these briefly, and notes the need for additional field testing before general acceptance can be expected.

6. GAS AND LPG STORAGE

Methane Liquefaction

Nonconventional Storage of Natural Gas. B. E. Eakin. Paper CEP-60-5. (New York: American Gas Association, 1960, $.25.)

Several techniques were investigated for the storage of large volumes of natural gas in below-ground structures. Storage of natural gas in its liquefied state appears to have many advantages over either absorption in LPG, adsorption on activated charcoal or Fullers earth, or chemical combination as solid hydrate. Comparisons of cost estimates indicate that a mined cavern designed to store one billion SCF of natural gas as liquid may cost only ½ to ¾ as much as standard above-ground storage tanks for the same total volume. Construction cost estimates for a steel-roofed below-ground storage pit were only ⅛ to ¼ as high as standard tanks. Calculated evaporation rates from the below-ground storage systems are equivalent to, or less than, those reported for above-ground tanks.

Tanks

Tank Construction. C. Dobell (assigned to The Preload Co., Inc.) U.S. 2,932,964 (1960) April 19.

Concrete tank for fluids is claimed in which a cylindrical prestressed sidewall is mounted on a base. This sidewall is separated from the base by a continuous

elastic connector embedded in both base and sidewall. It is of sufficient strength to allow maximum movement but it can withstand any hydraulic pressure to which it may be subjected. The top of the tank is attached to the sidewall by a similar connector in the same manner.

Underground Storage

Aquifers for Underground Natural Gas Storage. Part 3. Lease Rights; Drilling; Well Spacing; Service Facilities. J. A. Kornfeld. *Am. Gas J. 187,* 35 (1960) June (4 pp.)

The third part in the series of articles on the subject of underground natural gas storage in aquifers covers lease rights aquisition, drilling contract, well spacing, drilling, logging, and completion of input, output and service facility wells. (Part 1, see *Gas Abstracts 16,* 81 (1960) April and Part 2, *Ibid.,* 107 (1960) May)

Back-Pressure Tests on Gas-Storage Projects. C. J. Walker, J. S. Miller and H. N. Dunning. Paper GSTS-60-4. (New York: American Gas Association, 1960, $.25.)

The Bureau of Mines, in cooperation with the American Gas Association, has maintained an active interest in gas well testing because of implications of such test procedures on consumption and efficient production of natural gas. Basis for such tests was provided by the back-pressure method of Rawlins and Shellhardt and the isochronal performance method by Cullender. Both methods were used in this study to test six gas storage reservoirs.

Conditioning of Gas from Underground Storage. O. G. Howe. Paper CEP-60-4. (New York: American Gas Association, 1960, $.25.)

Paper is restricted to some of experiences of the Oklahoma Natural Gas Co. at its Depew underground storage cavity. A brief history of the storage facilities is given.

Gas Storage at 5000 psi Imposes Unconventional Construction Methods. F. Trillis. *Petrol. Eng. (Management) 32,* D-37 (1960) May (4 pp.); **Pipeline Evolution from Crude Logs to 5000 psi Systems.** *Gas 36,* 112 (1960) June (6 pp.)

When Leidy field (Pa.) began operations in 1950, the first well had an open flow of 15 MMCF/day with a rock pressure of 4200 lb. During the 1959-60 season, the field delivered 12 billion CF of gas. The spadework for this rate was begun in 1955 when, for various economic reasons, it was decided to use the reservoir to optimum capacity at original rock pressure. This necessitated a surface injection pressure of 5000 psig. In turn, the high pressure required heavy wall pipe and greater thickness/diameter ratios. First stage in the development of a 5000-psi injection system was construction of 13 miles of 12-in. pipe. Also involved: 22.5 miles of 10-, 8-, and 6-in. laterals serving the 85 wells within the pool.

Mined Cavern Storage for the Gas Industry. S. E. Scisson. Paper CEP-60-2. (New York: American Gas Association, 1960, $.25)

Presentation covers both present and possible future uses of mined storage caverns by the natural gas industry. A brief history of storage and a discussion of basic geologic and economic requirements for successful planning of these projects are included.

Protection of Underground Storage Wells. W. R. Lambert. Paper GSTS-60-9. (New York: American Gas Association, 1960, $.25.)

Control of well casing corrosion is similar to the control of corrosion on horizontal pipelines. As a result, much the same approach is pursued to retard casing corrosion as is taken on pipelines. Well casing may be controlled by insulation of the structure, protective coatings, and impressed currents. The author describes a combination of the above as one that provides the most favorable results.

Underground Storage of High Pressure Petroleum Gases. P. G. Carpenter (assigned to Phillips Petroleum Co.) U.S. 2,930,197 (1960) March 29.

Method is claimed for introducing and withdrawing a high-pressure petroleum gas from an underground storage system which comprises absorbing the gas in an absorption oil, passing the mixture of oil containing absorbed gas into the underground storage system, and utilizing the natural temperature gradient in the earth to fractionally distill the oil and gas mixture. An oil having 5 to 20 carbon atoms per molecule can be used for absorbing a hydrocarbon gas having up to 3 carbon atoms per molecule.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Two-Stage Burner Apparatus. G. H. Smith (assigned to Union Carbide Corp.) U.S. 2,934,410 (1960) April 26.

Two-stage burner for pyrolizing, mixing or atomizing fluid fuels, such as hydrocarbons, to produce acetylene is claimed. The burner is provided with two successive stages separated from each other by a throat section of reduced cross-sectional area. Fluid fuel and oxidant are injected into the burner at a velocity greater than 0.5 Mach number and mixed in a constricted throat at an angular impingement. The hot combustion products are then passed through a second constricted throat section where they are mixed with fluid stock at sonic velocity. End products are passed through a quenching zone and recovery unit.

Coal

X-Ray Scattering Intensities of Coals Treated with Lithium in Ethylenediamine. S. Ergun and I. Wender. *J. Appl. Chem. 10,* 189 (1960) May (4 pp.)

X-ray scattering intensities have been obtained of seven vitrinites of different rank and a natural graphite before and after treatment with lithium in ethylenediamine.

Scattering intensities showed extensive changes in the arrangement of carbon atoms. The major apparent change occurred at low and moderately low scattering angles. The peaks attributed to parallel packing of aromatic layers were displaced to lower angles corresponding to increase in *d*-spacings from about 3.6 to 4.6 A. These findings suggest that conversion of planar aromatic layers to buckled hydrogenated rings has occurred.

Coal Hydrogenation

Gaseous Hydrocarbons from Coal. R. W. Hiteshue, P. S. Lewis and S. Friedman. Paper CEP-60-9. (New York: American Gas Association, 1960, $.25.)

Experimental results are discussed for producing hydrocarbon gases from coal by hydrogenation, by reaction with high pressure steam, and by complete carbonization. The latter method refers to a type of low-temperature carbonization that produces only high Btu gas and char. In hydrogenation of bituminous coal, an increase in hydrogen pressure from 250 to 6000 psig at 800°C resulted in increasing yields of gaseous hydrocarbons from 7600 to 37,000 CF/ton of coal. In the reaction of coal and steam at 800°C, an increase in pressure from 1000 to 6000 psig resulted in increasing yield of combustible gases from 18,000 to 40,000 CF/ton. Combustible gases were largely H_2 and CH_4 with small quantities of CO. A high Btu gas can be produced by complete carbonization of bituminous coal. Cost of producing high Btu gas by this technique would be less than by conventional methods.

Studies on the Dielectric Properties of Indian Coals. Effect of Acetylation and Hydrogenation of Coal on Its Dielectric Behavior. D. K. Sen, S. K. S. Gupta, K. A. Kini and A. Lahiri. Part 1. *J. Sci. Industr. Res. (India) 19B,* 184 (1960) June (3 pp.)

Dielectric constants of coals and their acetylated products were measured and expressed as a function of temperature of carbonization up to 600°C. It was found that the dielectric constant of the original coals decreases on acetylation. Sudden increase in the dielectric constant of original coals observed at 600°C was attributed to an increase in electrical conductivity of coals in the region of this temperature; this increase in dielectric constant was observed at a lower temperature in the case of acetylated coals. Hydrogenated coals were found to exhibit a behavior similar to that observed with acetylated coal.

Equilibria

Use These Ks in Hydrofining. J. M. Prausnitz and J. H. Duffin. *Petrol. Refiner 39,* 213 (1960) May (10 pp.)

In recent years an increase in petroleum refining operations using excess hydrogen at moderate pressures was observed. Design calculations for separation of hydrocarbons from hydrogen require equilibrium data on the solubility of hydrocarbons in compressed hydrogen; the authors report K values for hydrocarbons in the C_4 to C_{10} range in contact with hydrogen at pressures up to 2500 psia. Article includes 17 charts.

Ethylene

Estimate Ethylene-Methane Separation. W. A. Mason. *Petrol. Refiner 39,* 233 (1960) May (4 pp.)

Separation of methane and lighter gases from ethylene and heavier products can be explored easily and quickly with the charts given. One chart is for absorption and another for fractionation. It is possible now to make trial calculations to find an optimum separation scheme. Then the more detailed and accurate computations can be confined to a small number of alternatives.

Gasification

The Kinetics of Carbon Gasification. J. D. Blackwood. Part 1. *Coke and Gas 22,* 190 (1960) May (6 pp.)

Present-day knowledge of the basic mechanism and kinetic features of the various reactions which contribute to the gasification process is still very inadequate, particularly in regard to influence of high pressure and temperature on reaction rate. For these reasons the author has investigated the more important basic gasification reactions under conditions of high temperature and pressure. A review of the reaction of carbon with oxygen and water vapor is given.

Hydrogasification

Natural Gas Supplements by Cyclic-Regenerative Hydrogasification of Oils. J. M. Reid, W. G. Bair and H. R. Linden. (Chicago: Institute of Gas Technology, Research Bull. No. 28. March, 1960)

Results of a study of high-Btu oil gas production by cyclic thermal cracking of petroleum oils are presented. Experimental data were obtained with a pilot-size four-shell cyclic-regenerative oil gas set of improved design, with a nominal process oil capacity of 50 gallons per hour, and constructed to operate at gasification pressures up to 50 psig. The use of process hydrogen greatly improved gasification results. The product gas approached the heating value, specific gravity and combustion characteristics of natural gas in such operations (hydrogasification). Since economical sources of hydrogen are required to make the process practical, existing methods of producing hydrogen are reviewed. Production of hydrogen as an integral part of the process, by steam reforming of natural gas over nickel catalysts, was studied.

Hydrogenation

Hydrogen Processing in Modern Refining. C. E. Slyngstad and F. L. Lempert. *Petro/Chem Eng. 32,* C-13 (1960) May (6 pp.)

Hydrogen processing is applicable in modern refining to reduce the number of treating processes, to provide feed stocks which improve processing yields and decrease catalyst usage, and to eliminate either coke or No. 6 fuel oil marketing problems. Further, hydrogen processing will reduce pollution and corrosion both in refinery and in areas of product usage. The economics of hydrogen treating lighter boiling streams are excellent, while those for heavier boiling streams depend on feed stock, product quality and sales potential.

Inert Gases

New Metal Working Plant Features Argon-Pressurized Pure Atmosphere. *Heating Piping & Air Conditioning 32,* 114 (1960) May (3 pp.); **Gas Chamber for Tough Metals.** *Business Week,* 91 (1960) June 11 (2 pp.)

If molybdenum, tungsten, columbium and tantalum can be processed in an atmosphere of 99.995% pure argon, then oxidation and nitridation can be prevented. The major difficulties in building this facility was to provide optimum safety for the technicians, who have to wear "space suits." Another difficulty was to keep the expensive argon gas from leaking out of the inert fabrication plant and to maintain atmospheric purity despite frequent opening and closing of the locks.

LPG

Automatic High-Pressure LPA-Gas Installation for Peak-Shaving. W. Mergner. Paper CEP-60-7. (New York: American Gas Association, 1960, $.25.)

Complete description of Public Service Electric and Gas Co.'s (New Jersey) LPA-gas installation is given.

Methanation

Synthesis of High-Btu Gas from Carbon Monoxide and Hydrogen Using a Hot-Gas-Recycle Reactor. D. Bienstock, J. H. Field, A. J. Forney and H. E. Benson. Paper CEP-60-14. (New York: American Gas Association, 1960, $.25.)

A high-Btu gas can be synthesized by catalytic methanation of a mixture of 2.5 to 3 parts of H_2 to one part of CO, obtained in the gasification of coal, using a steel catalyst followed by Raney nickel in a hot-gas recycle system. Conversion of 99% of the H_2+CO yields a fuel gas with a heating value of 983 to 1130 Btu/CF and containing 78% to 96% methane, no CO, and very small amounts of unsaturates. With the steel catalyst alone, conversions were 85% to 90%, giving a fuel gas of 810 to 868 Btu/CF, or 847 to 975 on a CO_2-free basis.

Oil Gas

Conversion of a Carburetted Water Gas Set to Thermal Process of Manufacture of High Btu Oil Gas. C. B. Reilly. Paper CEP-60-11. (New York: American Gas Association, 1960, $.25.)

Public Service Electric and Gas Co., N. J. converted, at its Trenton gas plant, a standard hand clinkered carburetted water gas set to a thermal process for manufacturing high Btu oil gas. The experience gained by operating this unit during the past winter is described in detail.

Study of Cracking Plants for Liquid and Gaseous Hydrocarbons. H. Pichler and T. Heike. *Gas- u.-Wasserfach 101,* 465 (1960) May 6 (4 pp. German text.)

Oil cracking plant, operated by the thermal process at the gasworks in Heidenheim, Germany, is described and illustrated. Efficiency tests were performed for four days and the data compared with the predicted efficiency values for the plant.

Ore Reduction

Process for Reducing Iron Ores at Low Temperatures. K. von Kaken (assigned one-third to J. B. Hahn.) U.S. 2,932,563 (1960) April 12.

Brown magnetic iron oxide, γ-Fe_2O_3, is reduced to pure iron in a process where the finely ground ore is mixed with the reducing gas to be fluidized and then fed into the top of a reducing zone of a vertical shaft furnace at 350° to 540° C. Finely-ground coal or carbon reductant is blown with reducing gas at several lower levels in the shaft, and the mixture is allowed to settle to a cooling zone on base. Reduction of other iron ores such as magnetite and pyrite residue can be carried out by pelletizing them with at least 30% of gamma-iron-oxide and then burning them in a blast furnace.

Use of Natural Gas in an Experimental Blast Furnace. N. B. Melcher, J. P. Morris, E. J. Ostrowski and P. L. Woolf. *U.S. Bur. Mines Rep. Invest. 5621.* (Pittsburgh: The Bureau, 1960.)

By injecting natural gas through auxiliary tuyeres into the smelting zone of an experimental blast furnace, the investigators succeeded in reducing the coke consumption by approximately one third. This caused a 30% increase in pig iron production with no increase in wind rate. Sharp reduction in gas consumption occurred when high hot blast and high wind rates were used, although the gas injection rate in percent of air blown remained constant.

Petrochemicals

An Industry Maps Its Mature Years. R. F. Messing and J. W. Bradley. *Chem. Eng. 67,* 54 (1960) May 30 (4 pp.)

Latest statistics show that the petrochemical industry has crossed the threshold into maturity, and complications have already set in. A flow chart of major petrochemicals shows the relationship between major products, markets, starting materials and processes which are involved. Of particular interest is the close interrelationship between the products of this industry and several alternate paths available to reach a given family of end products. Each time a product recurs, a new set of conditions for economic choice is defined.

Propylene

Pure Propylene Feeds Growing New Resin Industry. *Chem. Eng. 67,* 78 (1960) May 30 (4 pp.)

Sun Oil Co.'s new $2 million propylene unit at Marcus Hook, Pa. refinery waits for the polypropylene market to start mushrooming. The plant operates now at about ⅛ of its rated capacity and puts out a product having the extreme purity needed to make polypropylene resin. Its main customer now is AviSun's propylene plant. A flow sheet of the propylene, gas purification and polymerization plant is presented.

Pyrolysis

Process and Apparatus for Treating Petroleum Oils and Solid Fuels. C. Glinka. U.S. 2,931,765 (1960) April 5.

Water-containing particulate solid carbonaceous fuel of known bitumen-producing capacity and petroleum residual oils, boiling mostly below 250°C, are mutually converted to useful products by blending the fuel (coal shale) with the oil heated to 350°C under 30 atm pressure. Evaporation of oil is prevented by boiling off the steam and filling the pores of the solid fuel with oil. The mixture is raised to 400°C to generate liquid bitumen. The oil is separated and the solids are raised to 500°C at reduced pressures (0.5-5 atm) to crack the adhering oil to lower hydrocarbons and gas.

Reformed Gas

Hasche Furnace Operations on "H" Fuel. C. R. Prichard. Paper CEP-60-6. (New York: American Gas Association, 1960, $.25.)

Nantucket (Mass.) Gas & Electric Co. installed two Hasche units, rated at 20 MCF per hour each, and were put into operation on October 4, 1959. Net operating efficiency, including fuel used for vaporization, has been in the neighborhood of 95%. A schematic diagram of the unit and a condensed mass spectrometer analysis of the gas are given.

8. GAS DISTRIBUTION

Distribution Systems

Backfilling and Soil Stabilization. R. H. Ormston. Paper DMC-60-27. (New York: American Gas Association, 1960, $.25.); *Amer. Gas J. 187,* 22 (1960) June (7 pp.)

Protection of underground structures from mechanical failure by proper surface restoration and soil settlement due to construction operations are outlined. Properties of soil and its stabilization are discussed.

Should Stub Services Be Installed Ahead of Street Paving? R. L. Bulot. Paper DMC-60-26. (New York: American Gas Association, 1960, $.25.); *Am. Gas J. 187,* 29 (1960) June (2 pp.)

Studies were made of all extensions, additions and retirements of stub services during the period of 1940 to 1958. Time lapse from installation to extension was tabulated and an analysis of the findings was made. During the years 1949 and 1950 a large paving program was in progress and special attention given to selection of stub service installations. The results revealed by these studies indicate not only fewer stub extensions than expected during the first five years after installation, but fewer extensions even in later years.

Fluid Flow

Flow Conditions Peculiar to Medium High Pressure Distribution Systems. R. J. Gustafson. Paper DMC-60-23. (New York: American Gas Association, 1960, $.25.)

An investigation was conducted to explore the flow conditions in gas distribution systems, as far as Reynolds number, pipe roughness and pipe diameter are concerned. It was found that none of the existing equations describe adequately the transition zone between smooth-pipe and fully turbulent flow conditions. Variation of transmission factor with Reynolds number was generalized and applied to all diameters of pipe from 2 to 30 inches. Substitution of this expression into the general flow equation yielded an equation in which pressure drop varies as the 1.95-power of flow rate. A comparison of the proposed expression for transmission factor in the transition zone between smooth-pipe and turbulent flow was made with other commonly used equations, and the accuracy found to be improved through this range, and acceptable above and below the limits of the transition zone.

Leakage

Evaluation of Current Practices on Hot Spot Protection and Leak Surveys. W. R. Lambert. Paper DMC-60-32. (New York: American Gas Association, 1960, $.25.); **Evaluation of Current Practices in Hot Spot Protection.** *Gas Age 125,* 36 (1960) May 26 (3 pp.)

Author discusses results of inquiries obtained from 30 companies throughout the United States regarding their practices on hot spot protection and leak surveys.

Methods of Leak Repair and the Repair of Corroded Pipe. C. J. Allen. Paper GSTS-60-6. (New York: American Gas Association, 1960, $.25.); **Methods of Leak Repair and Repair of Corroded Pipe.** *Gas Age 125,* 29 (1960) May 26 (3 pp.)

Historical facts of the Cities Service Gas Co., Okla. which have bearing on methods of leak repair are outlined. Topics discussed based on experience are: leak detection and record keeping, types of leak repair, organization and equipment used, and yard-reconditioning of corroded pipe.

Mains

Ductile Iron Pipe. R. Clay. *Gas 36,* 54 (1960) June (6 pp.)

Pioneering efforts of Peoples Gas Light Coke Co. (Chicago) in the use of ductile iron pipe are described. Objective of search was to find a pipe that would combine the established corrosion resistant properties of cast iron with the strength and ductility of steel. Interest in ductile iron pipe was heightened after a study in its application by the French gas industry. Today, Peoples has over 100 miles of ductile iron pipe in the ground, making it the first and foremost user in this country.

Testing New Mains and Service Installations, Pipe Coatings and Corrosion Control. J. W. McAmis. Paper DMC-60-36. (New York: American Gas Association, 1960, $.25.); **Testing New Mains, Services, Pipe Coatings and Corrosion Controls.** *Gas Age 125,* 27 (1960) May 26 (3 pp.)

Effective control of corrosion of gas mains or services begins in the early planning stages. Considerations which should be taken at the inception of a new extension are outlined and testing methods of mains and services are discussed.

Viewing of Main Interiors by Television. C. P. Xenis. Paper GSTS-60-8. (New York: American Gas Association, 1960, $.25.); **Viewing Main Interiors by Television.** *Gas Age 125,* 17 (1960) May 12 (3 pp.); **Using TV to View Main Interiors.** *Am. Gas J. 187,* 42 (1960) June (3 pp.)

Consolidated Edison Co. of New York finds a new tool for internal inspection of pipe in the TV camera which was modified by various arrangements to perform its special task. A carriage for transporting the camera into the pipe was constructed and legs of various lengths were provided for centering the camera in mains of 12 to 24 inches in size. A lighting system was developed which consisted of 12 spotlights with a protective shield. Methods of viewing the inside surfaces are described.

Metering

Recent Development in Demand Metering. A. Lovretin, Jr. Paper DMC-60-31. (New York: American Gas Association, 1960, $.25.)

Purpose and requirements of demand metering and modern demand recorders is outlined. The author also discusses processing of mass data, magnetic and punched paper tape recorders as well as gas meter demand attachments.

Odorization

Odorant Concentration as Compared to Odor Intensity. J. S. McClure. Paper CEP-60-10. (New York: American Gas Association, 1960, $.25.)

Report of an investigation of the sensitivity of human olfactory nerves to changes in concentration of thiophane. Results reveal that a 150% change in concentration is necessary to establish a change in odor level. Comparative odor intensity vs. odorant concentration for thiophane as well as for light aliphatic mercaptans is presented. Results show that for an equal change in odorant concentration, mercaptans affect the odor level to a greater degree than thiophane. This cyclic sulfide odorant, however, has a lower threshold odor level.

Odorizing—An Obnoxious Necessary Evil. O. F. Nelson. Paper CEP-60-8. (New York: American Gas Association, 1960, $.25.)

Problems and procedures at the Northern Illinois Gas Co. are reviewed. Pumps for metering odorants were tested for easy maintenance and ruggedness. Basic design and specifications for a diaphragm type pump are described in detail.

Peak Loads

Peak Shaving Problems of Distribution Companies as Related to Winter Gas Loads. G. W. Warrick. Paper GSTS-60-17. (New York: American Gas Association, 1960, $.25.)

Determination of the portion of winter peak supplied from pipeline flow gas and that to be supplied by peak shaving facilities is a problem of economics. Proper solution of this problem depends upon carefully prepared load studies and on probable weather. A method of load analysis and a discussion of weather probabilities is the essence of this paper. (See also *Gas Abstracts 16,* 112.)

Pipe Joints

Seals for Gas-Carrying Pipe Lines. H. K. Beeley. U.S. 2,931,671 (1960) April 5

Seal for gas pipe joints is claimed which comprises an "s"-seal between the outer shoulder of the reduced spigot end and the outer periphery of the bell end of the cooperating section of pipe. Also within the bell and upon the reduced surface of the spigot are inserted three sealing rings comprising a middle part with divergent sloping end surfaces and closely adjacent rings with convergent sloping ends engaged on either side. Internal gas pressure against the two seals tends to tighten the joint.

Weather Forecasting

Company Employed Meteorologist as Aid to Dispatchers. R. E. Amsberry. Paper GSTS-60-1. (New York: American Gas Association, 1960, $.25.)

History of the events leading to employment of a company meteorologist at El Paso Natural Gas Co. is presented and attempts are made to answer some of the pertinent questions regarding use of weather forecasts prepared within a dispatching unit. Activities which are involved in miscellaneous forecasting are described and practicability of one meteorologist handling weather duties for a large company 24 hours a day, 7 days a week, are discussed.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Take Off Those Blinders. Sell the Whole Heating Market. *Butane-Propane News 22,* 41 (1960) June (15 pp.)

Examination of four challenging, relatively untapped markets for LPG are discussed. These new promising markets are: domestic air conditioning, commercial and industrial heating and air conditioning, swimming pool heating and motel heating and air conditioning.

Air Pollution

Blast-Furnace-Gas Cleaning for Iron and Ferromanganese Production. J. S. Mackay and J. F. Kearns. *J. Eng. Power 82,* 68 (1960) Jan. (5 pp.)

Process for removing the superfine smokes from ferromanganese blast-furnace gases having low investment and operating cost is discussed. The method solves both the air and stream-pollution problems. The furnace gas is cleaned from 10 to 15 grains/CF to less than 0.01 grains/CF by a wet-washing procedure in a venturi scrubber. The alkali cyanide stream pollution problem is solved by the control of pH and complete recycle of the liquors so that the cyanide is stripped by the incoming gas and is subsequently burnt in the stoves or boilerhouse. The liquor is separated from solids in a Dorr thickener. The solids are removed in the under-

flow as a thick slurry which is returned to the furnace or dumped in the ore yard. The overflow is pumped back to the venturi. The chemistry and equipment of the process are described.

New Way to Scrub Incinerator Gases. S. Smith. *Air Eng. 2,* 40 (1960) May (3 pp.)

For flue-fed incinerators and in multistory buildings one manufacturer incorporates a fixed gas-by-pass to atmosphere which operates automatically during short peak load periods when gas volumes are excessive. The basket will trap any large pieces of refuse which would interfere with operation of scrubber and permits free discharge of flue gas and by-passing of the scrubber in case of power failure. The hot dirty flue gases are first sprayed by means of a group of low pressure spray nozzles and pass then through an impingement baffle plate cleaning stage. This stage consists of a plate having 600 to 3000 orifices per square foot. The directed impingement on a wetted target dynamically precipitates particles and entraps them in the scrubbing liquid.

The Smogless Automobile. F. L. Hartley, C. C. Moore and J. B. Gregory. *J. Air Pollution Control Assoc. 10,* 143 (1960) April (4 pp.)

Five sources of air pollution from today's cars are: external and internal carburetor vents, gasoline tank and crankcase vents and exhaust pipe. To produce a smogless automobile, it is necessary to either plug up the holes or modify the design, including hydrocarbon and carbon monoxide eliminating equipment. Suggestions for correcting the first three air pollution sources are presented and a proper design of afterburner should handle the last two.

Automation

Aspects of Automation in Gas Distribution. E. J. Dasley. *Gas World 151,* (1960) May 14 (2 pp.)

Aim of this article is to recapitulate on recent growth of supervisory control in the distribution section of gas industry, to describe how the schemes evolved have been governed by the type of equipment available, and to show how existing advanced forms of instrumentation may be utilized. Instrumentation of distribution is selected as a convenient method to illustrate varying stages through which it is necessary to pass, so that successive advances are made.

Burners

Flame Retention Gas Burner Nozzles. W. Ferguson (assinged to National Airoil Burner Co.) U.S. 2,932,349 (1960) April 12

To prevent flashback in a burner for gases containing large quantities of free hydrogen, an expanded mixing chamber beyond the venturi inspirator throat is claimed, with the chamber front closed by a thick plate. The plate carries a central reentrant conically-flared insert as a main flame port, and also multiple smaller ports spaced radially around which comprise about half the total port area. Cooling of central port and multiple arrangement eliminate flashback and improve the combustion.

Gas Fueled Pilot Burner. R. D. Beck (assigned to Minneapolis-Honeywell Regulator Co.) U.S. 2,933,132 (1960) April 19

Pilot burner is claimed which is pressed from a blank of sheet metal by bending the sheet into a shallow U-shape, then drawing it to curve the sidewalls into abutment and thereby form a flattened cup. One side is punched and a burner tube attached by brazing. The wide tip thus yields a ribbon- or fan-like flame.

Lid for a Burner of a Gas-Ring or a Gas-Cooker. E. M. J. Gonsalves. U.S. 2,931,432 (1960) April 5

Improved burner lid is claimed for a burner in which the flames issue from ports formed 1) between the grooved upper rim of the burner and the smooth lower surface of a superimposed head, 2) between the smooth upper rim and the grooved lower surface. The new lid consists of an overhanging cylindrical collar positioned through part of its circumference in such a manner that the gas vents formed in that part of the circumference are shut off by the collar so that the flames can be directed to burn from the remaining portion of the circumference.

Combustion

Computation of the Equilibrium Composition of Burnt Gases. R. L. Potter and W. Vanderkulk. *J. Chem. Phys. 32,* 1304 (1960) May (4 pp.)

Multicomponent chemical equilibrium composition problem is discussed generally, and a formulation of it is presented in a form suitable for digital computer calculations. A geometric interpretation of the equations used to specify the chemical system is also given. The solutions thus obtained are useful in flame temperature, detonation, and shock calculations, and in the analysis of engine cycles. Several such programs have been formulated and published.

Flammability Limits of Methane and Ethane in Chlorine at Ambient and Elevated Temperatures and Pressures. A. Bartkowiak and M. G. Zabetakis. *U.S. Bur. Mines Rep. Invest. 5610* (Pittsburgh: The Bureau, 1960.)

The lower flammability limit of methane at 0 psig and ambient temperatures is 5.6 volume percent in chlorine, 5.2 in oxygen and 5.0 in air. The corresponding upper limit values are 70, 60.5 and 15 volume percent, respectively, so that the range of flammable mixtures is greater in chlorine than in oxygen or air. The lower flammability limit of ethane at 0 psig and ambient temperatures is 6.1 volume percent in chlorine, 3.0 in oxygen and 2.9 in air. The corresponding upper limits are 58, 66 and 12.5 volume percent, respectively. In this instance the range of flammable mixtures is greater in oxygen than in chlorine or air. Generally, the limits of flammability for both methane-chlorine mixtures and ethane-chlorine mixtures widen with increases in temperature and pressure.

Drying

Spray Drying of Milk, Coffee and Eggs. T. R. Canner and C. B. Cole. *Ind. Gas* (American) *38,* 4 (1960) May (5 pp.)

Spray drying has practically replaced roller method in the rapidly growing production of dried milk products, instant coffee and egg solids. Spray dryers can be heated by steam, by direct gas firing or by using a combination of both of these methods. A schematic drawing of a spray dryer is presented. Air is drawn in, filtered, and blown through a heating assembly. The heated air is then directed through a plenum chamber and is blasted past the spray nozzle assembly.

Flame Research

The Influence of Molecular Structure on the Structure of a Weak Shock Wave. A. Szaniawski. *Arch. Mech. Stos. 11,* 317 (1959) March (16 pp.); (From *Appl. Mech. Rev. 13,* 352 (1960) May.)

Influence of the relaxation phenomenon and the variability of specific heat on the thickness of a weak shock wave are discussed. In the analysis of the relaxation phenomenon three independent groups of degrees of freedom are considered: translational, rotational and vibrational group. It is stated that the influence of relaxation is considerable and disregard of this phenomenon leads to errors. It is found that for molecules composed of not more than five atoms the influence of variation of specific heat is small. It is believed that for molecules of more than five atoms this influence will also be significant.

A Possible Mechanism for the Production of $O_2^*(^3\Sigma_u)$ in Flames. R. J. Fallon, I. Tobias, J. T. Vanderslice and W. G. Maisch. *Can. J. Chem. 38,* 743 (1960) May (3 pp.)

Article suggests a mechanism for the production of thermally excited $O_2^*(^3\Sigma_u)$ in flames on the basis of some recently determined potential curves of O_2. The methods of obtaining these curves are discussed in the reference section and those of importance in the present discussion are illustrated in a figure. In the H_2/O_2 and NH_3/O_2 flat diffusion flames, a continuum was observed that lies roughly in the same region as the Schumann-Runge emission. A continuum was also observed in flames containing CO. In conclusion the authors suggest that the $O_2^*(^3\Sigma_u)$ found in flames burning with O_2 is formed by the thermal collision of two $O(^3P)$ atoms interacting along the $^3\pi_u$ repulsive curve which undergoes a radiationless transition to the $^3\pi_u$ state.

Industrial Heating

Century Old Concern Is Integrated from Melt to End Product. A. Q. Smith. *Ind. Heating 27,* 948 (1960) May (5 pp.)

Century-old manufacturer in the newer industrial area of the Midwest is The Adams and Westlake Co. in Elkhart, Ind. Manufacturing or end product operations essentially consist of general machine shop work and many mill products come from their own foundry where brass, bronze and aluminum are cast or extruded. Natural gas is used exclusively for all hot metalworking.

New California Plant Brings Automation to Soil Pipe Industry. F. W. Young. *Ind. Gas* (American) *38,* 9 (1960) May (3 pp.)

Two problems that Alabama Pipe Co. faced in putting pipe-casting into operation were that of cupola efficiency and air pollution. Both of these problems were successfully solved by the use of natural gas. The combustion equipment consists of one premixer manifolded to nine burners which have a total input capacity of 1000 CF of natural gas per hour. The air pollution problem was completely controlled by an elaborate air purifying system. Fumes from the cupola are first passed through a gas-fired afterburner operating at 1300°F to complete the combustion of any unburned material.

Versatile Barrel Furnace Line Improves Production Heat Treatment of Steel Bars. J. F. Black. *Ind. Heating 27,* 1002 (1960) May (6 pp.)

Stainless steel division of Jones and Laughlin Steel Corp. is heat treating steel bars in a continuous, barrel-type furnace installation. The furnace line is used to anneal several grades of stainless steel bars in the hot rolled or cold drawn condition, and to normalize other grades of steel. Among the many advantages are high-quality production in small floor space, automatic operation with very simple control equipment, and versatility. This furnace is made up of five separate heating units — each fired by natural gas, radiant-cup type burners — and an annular quench ring, making a heating machine 20-ft long by 5-ft wide.

Nitrogen Oxides

Air Pollution. Nitrogen Oxide Formation in Autoignition of Liquid Fuel Sprays. G. J. Mullaney. *Ind. Eng. Chem. 52,* 529 (1960) June (4 pp.)

Formation of nitrogen oxides in complex flames was studied using a shock tube technique. At an air temperature of 950°K before fuel injection, air pressure of 17 atm and a time interval of about 25 msec, the nitric oxide yield varied markedly with the fuel. There is some evidence that nitrogen-oxygen reaction kinetic data at high temperature can be used to estimate the amount of nitric oxide formed in the diffusion flame following autoignition. Its exponential dependence on temperature suggests that control of maximum combustion temperature in engines will have a large effect on nitric oxide formation which is an important factor in air pollution.

Pilot Lights

Ignition Device for Gas Apparatus, particularly for Gas Water Heaters with Enclosed Combustion Chamber. H. Dönges (assigned to Joh. Vaillant K.G.,) U.S. 2,932,348 (1960) April 12

In an enclosed air-flued combustion chamber of a water heater an improved pilot ignition burner is claimed, in which the pilot flame is carried in a small cylindrical chamber which slides within a guide tube fastened to the heater wall. In sliding, initially the chamber edge depresses a gas inlet valve, permitting the pilot to be lighted and allowing combustion air to enter

the pilot chamber through coinciding holes in pilot wall and guide wall. With slightly further sliding, the air holes close and a second pair of coinciding holes between pilot and heater are opened, while a second gas supply valve injects a larger flame into the heater combustion chamber while it is sealed from the room air

Space Heating

All Weather Comfort Standard. *Air Conditioning, Heating and Ventilating 57,* 57 (1960) May (3 pp.)

Recommended practices for insulating, ventilating, shading, and related factors for improved comfort and economy in electrically heated and /or air conditioned homes are outlined.

Ventilation

Power Venting of Gas Appliances. J. P. Jones. *Air Conditioning, Heating and Ventilating 57,* 53 (1960) May (4 pp.)

Power venting, or the use of mechanical energy to remove combustion products from a building, is fully discussed. Data are presented on fan selection and the design of ducts, as well as wiring diagrams for safety devices and the necessary controls.

10. EQUIPMENT AND INSTRUMENTATION

Fluidization

Treatment of Carbonaceous Solids. M. F. Nathan (assigned to The M. W. Kellogg Co.) U.S. 2,933,822 (1960) April 26.

Invention relates to a method and means for handling wet finely divided carbonaceous material in a fluid system. A process for fluidizing finely divided solids (coal) wet with liquid (water) is claimed in which the wet solids are introduced to a feed zone and densely fluidized solids of dried material are added. The dried solids are fluidized in a second zone by condensable gas (steam) where the temperature is kept above the boiling point of the liquid material. Wet and dry solids are proportioned to the feed zone and non-condensable gas (air) is used to provide fluidization of the flowing solids, yielding finely divided solids from the second zone and fluidizing gas for the feed zone.

Heat Exchangers

Mechanical Design of Heat Exchangers. A. J. Gram *Ind. Eng. Chem. 52,* 468 (1960) June (6 pp.)

Wide range of applications of heat exchangers in the chemical industry has led to a variety of constructions to accommodate many types of fluids and processes. To fit the majority of cases, standard tube-and-shell heat exchangers were developed by the industry, and the process of standardization continues to reduce heat exchanger first costs, implement rapid delivery and permit interchangeability of parts. Special types of heat exchangers required for unusual conditions are described.

Thermal Design of Heat Exchangers. D. S. Morton. *Ind. Eng. Chem. 52,* 474 (1960) June (5 pp.)

Basic thermal design must be correlated with mechanical design and application of heat exchangers. It is shown how optimum thermal design has to be operable as well as being adaptable to a sound and economical design. To illustrate the procedure involved when rating a shell-and-tube heat exchanger, thermal design calculations are given.

Piping

Cryogenic Piping System Design and Installation. R. B. Jacobs. *Heating Piping & Air Conditioning 32,* 141 (1960) May (16 pp.)

Cryogenic piping systems must be designed to operate through a temperature range from room temperature down almost to absolute zero or −459.6°F. Basic design considerations are the same as those for other fluids, but the designer must be aware of differences in the properties of materials, and differences in emphasis and orders of magnitude in the specifications due to the temperature range. How these low temperatures affect the fluid-mechanical design, selection of pumping equipmeat, heat exchanger design, piping system instrumentation, and the fabrication and installation of the piping system are presented. Precautions to be observed for safe handling of liquefied gases are also given.

Process Design

A Designed Experiment. Production of a New Chemical. C. L. Wilson. *Ind. Eng. Chem. 52,* 504 (1960) June (3 pp.)

First commercial-scale operation of a new chemical is carried out, usually on existing equipment, which permits market evaluation without excessive capital expenditure. In this study a designed experiment on production of a new chemical was carried out in equipment used for producing another material by a similar process. The planning and results of this experiment measuring cost, yield, and conversion rate are reviewed. This type of experiment provides valuable data for future production runs and design if the product meets market acceptance.

Process Engineering a Petrochemical Plant. D. J. Cestoni, R. E. Ringelman and L. R. Olson. *Chem. Eng. Prog. 56,* 73 (1960) May (5 pp.)

Three techniques used by process engineers at Fortier are described. The first example shows how a well-established technique, intensive analysis of accumulated plant records, is used to obtain an equation which describes plant operation. The equation was used to stabilize plant operation during the early phases. The second example shows how evolutionary operation, a new statistical technique, was used to achieve sizable process yield improvements. And the third technique shows how time-series analysis was used to study process dynamics in order to specify adequate control systems.

Temperature Measurement

Calibrating Thermocouples. W. F. Roeser. *Instruments and Control Systems 33,* 796 (1960) May (2 pp.)

National Bureau of Standards methods for calibration of platinum versus platinum-rhodium, copper-constantan, Chromel-Alumel, and iron-constantan thermocouples are described. Calibration points, accuracy and fixed points available for calibrating thermocouples are tabulated.

Effect of Thermocouple Cavity on Heat Sink Temperature. J. V. Beck and H. Hurwicz. *J. Heat Transfer 82,* 27 (1960) Feb. (10 pp.)

Analysis is made of problems associated with prediction of and correction for temperature disturbance created by thermocouples placed beneath the surface of a heat sink (or calorimeter) exposed to heat flux during reentry. Two important factors affecting temperature measurement are discussed: the disturbance created by the thermocouple itself, "hot spot" and the location of the thermocouple where the undisturbed surface temperature may be read with least overall error.

The Interpretation of the Stationary and Transient Behavior of Refrigerating Thermocouples. J. E. Parrott. *Solid-State Electronics 1,* 135 (1960) May (9 pp.)

Theory of stationary and transient behavior of refrigerating thermocouples is presented in an improved form, the Thomson effect, the temperature variation of electrical resistance and surface heat transfers all being taken into account. It is shown that considerable errors can arise from the use of inappropriate approximate expressions, both in the stationary state and in the calculation of time constants of the transient. In addition, errors arising from the neglect of temperature variation of thermal conductivity are estimated and shown to be small.

Resistance Temperature Detectors. V. W. Rose. *Instruments and Control Systems 33,* 790 (1960) May (4 pp.)

Principle, materials, design, uses and limitations of resistance temperature detectors is discussed. Industrial, hermetically-sealed detectors "drift" less than 0.05% over five years of continuous use. Their use simplifies instrumentation by permitting use of higher levels of output power than is available from either thermocouples or thermistors. They are more versatile than thermocouples because either a-c or d-c signals can be used.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Coatings

Bureau of Reclamation Tests and Evaluates Coatings for Dam Projects. *Corrosion 16,* 9 (1960) June (4 pp.) (Revision of paper by P. W. Lewis and J. L. Kiewit)

Bureau of Reclamation's use of protective coatings to control corrosion on metalwork in variable fresh waters of 17 western states is described. Standard specification materials are used successfully. Evaluation of new products and special tests for the selection of new materials is presented. Importance of proper application of coatings under field conditions and of inspections at all stages of coating work is emphasized.

Coatings—a Five-Year Forecast. M. H. Bigelow. *Chem. Processing 23,* 26 (1960) June (3 pp.)

Article concerns organic polymers which are applied manually or otherwise to form a protective or artistic surface. Paints, varnishes and lacquers as well as polymers utilized for coatings by hot-dipping treatments are included. However, natural resins, plastic laminates, and certain protective coatings formed from petroleum or coal-tar distillates are not considered in this report. Information was gathered through statistical sources and as a basis the 1954 Census figures were used. Paint production has increased at about the same rate as the Gross National Product, namely, 3.5% for trade and 3.4% for industrial types during the years 1948 to 1958. On this basis the 1965 paint consumption is estimated at a 930 million gal total.

Procedures and Techniques for Internal Cleaning and Coating of Plant Piping In-Place. *Corrosion 16,* 15 (1960) June (5 pp.) (Revision of paper by W. T. Theis)

Development of in-place method of cleaning and coating of pipelines during 1947-48 is outlined. Cleaning and coating methods as well as a procedure for selection of suitable coatings are explained. Five case histories of in-place coatings used to reduce internal corrosion are given.

Corrosion

Corrosion Control for Gas Production Facilities—A Case History. J. Wagner, Jr. Paper CEP-60-3. (New York: American Gas Association, 1960, $.25)

Extensive planned corrosion control program was undertaken by the gas production department of a large utility. This program, now in its eighth year, has increased safety and reliability in transport and storage of raw materials, curtailed major maintenance and replacement costs, provided protection of investment in new facilities and increased reliability of facilities used for standby and peak-shaving functions.

Inhibitors

Studies on Vapor Phase Inhibition. Performance of m-Dinitrobenzene and β-Naphthol at Different Humidities. K. S. Rajagopalan and G. Ramaseshan. Part 1. *J. Sci. Industr. Res. (India) 19A,* 275 (1960) June (5 pp.)

Performance of m-dinitrobenzene and β-naphthol as vapor phase inhibitors was investigated at different humidities and in the presence and absence of sulfur dioxide and sodium chloride employing test specimens of mild steel and copper, zinc and aluminum. Both inhibitors give satisfactory protection to steel under a variety of experimental conditions and they do not have an adverse effect on non-ferrous metals. Tensammetric studies have shown that the mechanism of inhibition differs in both cases.

Vapor-Phase Inhibition of Atmospheric Corrosion. S. E. Sexton. *Corrosion Tech. 7,* 147 (1960) May (5 pp.)

Vapor-phase inhibitors are a somewhat different ap-

proach to combating atmospheric corrosion. The metal article and the corrosion inhibitor are placed in close proximity and the protective vapors of the inhibitor surround the item. Both organic carbonates and nitrites have been used as such corrosion inhibitors. Dicyclohexylammonium nitrite and its solutions (which is the basis of present Shell vapor-phase inhibitors, VIP 260 and VIP 280), seem to prevent corrosion of ferrous metals. The development and the obvious advantages in long-term protection of these nitrites as well as methods of application to a diversity of products are described.

Insulation

Carbon Wool As an Insulating Material in Vacuum Induction Furnaces. R. H. Hiltz and D. P. Laverty. *Ind. Heating 27,* 1051 (1960) May (3 pp.)

In the last year a new form of carbon known as carbon wool has appeared. Similar in appearance to black hair, it is easy to handle due to its fibrous nature and is not dirty in application. The wool does contain a certain amount of volatile matter. This is easily outgassed at a temperature of 1700°F in a period of 10 to 12 hours. Reabsorption of such gases as water vapor upon exposure to the atmosphere is several orders of magnitude less than that reabsorbed by graphite powder. Loss of volatile matter does not impair the fibrous form and it does not revert to powder even after extended use.

Piping

Pipes and Pipelines for Gas Distribution. W. Moorcroft. *Gas World 151,* 770 (1960) May 14 (2 pp.)

Materials used for pipelines and initial testing methods are briefly discussed.

12. ANALYTICAL METHODS AND TESTS

Analytical Instruments

Basic Instrumental Schemes for Chemical Analysis. C. M. Albright, Jr. *Ind. Eng. Chem. 52,* 484 (1960) June (3 pp.)

Informed selection of chemical analysis instruments for specific requirements has become difficult owing to the great variety and complexity of techniques. A new approach to classification of analysis techniques is described. It is based on interactions between sample and energy in the forms of electromagnetic radiation, chemical reactivity, electric and magnetic fields and with thermal or mechanical energy. This system of classification permits rapid review of the various basic instrumental schemes of analysis and simplifies effective selection of specific problems.

Continuous Process Control. D. D. Friel. *Ind. Eng. Chem. 52,* 494, (1960) June (3 pp.)

Research on novel means for analysis of chemical streams has resulted in a variety of reliable instruments now used in many plants to control process operation and maximize product quality. Among the more important developments are electrochemical analyzers such as the coulometric moisture analyzer for gases and liquids. These are now commercially available. Included are reliable photoelectric analyzers which employ absorption of ultraviolet and visible radiation for measurement. A major improvement in detectors for chromatographic analyzers is also reported.

Chromatography

Plate Height in Gas Chromatography. J. C. Giddings, S. L. Seager, L. R. Stucki and G. H. Stewart. *Anal. Chem. 32,* 867 (1960) June (4 pp.)

Principal equations used for description of plate height in gas chromatography are examined with emphasis on the eddy diffusion term. Effect of pressure gradients is also examined. This evidence is useful in establishing the significance of various plate height equations and their parameters.

Programmed Temperature Gas Chromatography. S. D. Nogare and W. E. Langlois. *Anal. Chem. 32,* 767 (1960) June (4 pp.)

An equation expressing dependence of solute retention time on heating rate, mass flow rate of carrier gas, and starting temperature for linear temperature conditions was derived. Experimental results agree well with those derived by integration by computer. Under identical conditions, increasing the liquid phase polarity also increases retention time of each member of a polar homologous series by the same amount.

Separation and Determination of Argon, Oxygen, and Nitrogen by Gas Chromatography. E. W. Lard and R. C. Horn. *Anal. Chem. 32,* 878 (1960) June (2 pp.)

Mixtures of argon, oxygen and nitrogen are separated and determined by gas chromatography. Using a 5A Linde Molecular Sieve column, nitrogen is separated at 25° C and the argon-oxygen fraction separated at −72° C. Total analysis time was 16 minutes. Other types of Linde molecular sieves were investigated and found to be unsatisfactory for the separation of argon and oxygen.

Fractionation

Fractional Thermogravimetric Analysis. P. L. Waters. *Anal. Chem. 32,* 852 (1960) June (7 pp.)

Fractional thermogravimetric analysis provides information on the composition or properties of volatile matter. In one application a specific fraction of volatile matter is trapped in the upper section of a vessel which contains the sample; weight loss is then due to the remaining fraction. Thus by elimination it is possible to follow variations in rates of evolution of tar, liquid and gases from coal and similar compounds during pyrolysis. In another application, the method is used to determine carbon and hydrogen evolving in volatile form by oxidizing carbon to carbon dioxide and hydrogen to water. A slightly modified version is used for volumetric measurements of gas evolution. Data combined with corresponding gravimetric measurements

make it possible to calculate average density of gases evolved during decomposition.

Hydrocarbons

Separation and Characterization of Polynuclear Aromatic Hydrocarbons in Urban Air-Borne Particulates. E. Sawicki, W. Elbert, T. W. Stanley, T. R. Hauser and F. T. Fox. *Anal. Chem. 32,* 810 (1960) June (6 pp.)

Method involving column chromatography and ultraviolet, visible, and fluorescence studies of fractions is employed for analysis of urban air-borne particulates. Hydrocarbon content of air-borne particulates from 100 communities indicates close similarity particularly in the ultraviolet-visible regions. A number of hydrocarbons are consistently found in air samples.

Hydrogen

Determination of Active Hydrogen Using Exchange with Deuterium. Infrared Spectrophotometric Method. W. R. Harp, Jr. and R. C. Eiffert. *Anal. Chem. 32,* 794 (1960) June (3 pp.)

Generalized infrared spectrophotometric procedure is devised for determining active hydrogen. The sample is dissolved in an excess of deuterium and the amount of OH in the deuterium phase measured in the 2.97 micron band; from this active hydrogen is calculated. Water-soluble or insoluble samples may be run with an accuracy of 2% of the amount of active hydrogen present.

Mass Spectrometer

Analysis of Nitrogen for Small Concentrations of Carbon Monoxide by Mass Spectrometry. G. P. Schacher, R. E. Rippers, and J. A. Hill. *Applied Spectroscopy 14,* 79 (1960) June (2 pp.)

A small concentration of carbon monoxide in any nitrogen containing sample is not easily and accurately measurable. Chemical conversion of the carbon monoxide to some other gas could facilitate such analyses. Schutze reagent is a rapid and quantitative oxidant for carbon monoxide at room temperature. The reagent is granular and conveniently prepared from silica gel, iodine pentoxide and sulfuric acid. To adapt the reagent to mass spectrometer determination of carbon monoxide in nitrogen, a reagent tube with a bypass tube is employed. Mass spectra obtained on two portions of the sample, one passed through the reagent, the other bypassing the Schutze reagent, differ at mass 44 and 28 by the conversion of carbon monoxide to carbon dioxide.

Metals

Photometric Determination of Traces of Cobalt in High-Purity Nickel. C. L. Luke. *Anal. Chem. 32,* 837 (1960) June (2 pp.)

Trace amounts of cobalt in nickel are determined by a modified nitroso-R method. Cobalt is separated from nickel before being photometrically determined. Cobalt is converted to cobaltic amine and nickel is precipitated as hexaminoperchlorate. In high purity nickel, 0.001 to 0.02% cobalt is determined.

Moisture

Apparatus for Measuring the Humidity of Gases. E. A. Rueger. U.S. 2,932,199 (1960) April 12

Humidity of gases is measured by a device comprising a closed receptacle having a porous wall through which gas can diffuse, a thermometer for gas temperature and a manometer to indicate pressure difference between the inside of receptacle and the gas. The manometer and diffusion vessel are movable horizontally along a humidity scale fixed to the face of the casing. A fixed temperature scale is etched on lower left and base of the casing front to form an angular coordinate on which a straight-edged pointer can be set. With pointer set at observed temperature, the manometer is moved to coincide with the edge of the indicator. Humidity is then read on an upper fixed scale opposite the pointer.

Oxygen

Coulometric Analyzer for Trace Quantities of Oxygen. F. A. Keidel. *Ind. Eng. Chem. 52,* 490 (1960) June (4 pp.)

Determination of low concentration of uncombined oxygen is necessary in an increasing number of process and research applications. A new approach to electrochemical analysis of oxygen suitable at concentrations to less than 1 p.p.m. resulted in an instrument which avoids problems ordinarily associated with the use of amperometric instruments. Freedom from effects of vibration, temperature, sample composition (other than oxygen), and electrode potential was achieved by employing quantitative coulometric reduction of oxygen at a specially designed porous electrode. No standard samples are required for calibration. This development was found applicable in a wide variety of oxygen analysis problems.

Sulfur

Rapid and Precise Method for Determining Total Sulfur in Coal. A. C. Bhattacharyya and B. P. Bhaduri. *J. Sci. Industr. Res. (India) 19B,* 212 (1960) June (3 pp.)

A rapid and precise method for determining total sulfur in coal, based on combustion of coal samples in platinum-rhodium gauze catalyst, was developed. Total sulfur after combustion is converted into sulfur dioxide and sulfur trioxide which are absorbed in hydrogen peroxide to form sulfuric acid. Sulfur is estimated as barium sulfate gravimetrically. Analytical values obtained agree with those obtained by Eschka method and are reproducible. Rapidity of the method can be increased by chelometric determination of barium sulfate.

Water

Water Demineralizers. O. T. Zimmerman and I. Lavine. *Cost Eng. 5,* 12 (1960) April (3 pp.)

Brief outline of various types of demineralizers is presented. Capacity and cost data for certain types of demineralizers are tabulated.

13. BASIC SCIENCE

Absorption

Absorption of Hydrogen by Palladium/Platinum Alloys. A. W. Carson, T. B. Flanagan and F. A. Lewis. Part 2. *Trans. Faraday Soc. 56,* 371 (1960) March (11 pp.)

The course of absorption of hydrogen from hydrochloric acid solutions by a series of palladium/platinum alloys was followed by measurement of relative electrical resistance and electrode potentials. Over the region of constant rate the activation energy for absorption from solution was found to be about zero and the rate to be first order with respect to hydrogen pressure. A possible mechanism of absorption is discussed.

Surface Potential Measurements. J. Pritchard and F. C. Tompkins. *Trans. Faraday Soc. 56,* 540 (1960) April (11 pp.)

Surface potential difference by adsorption of hydrogen atoms on evaporated films of copper, silver and gold, and the variation of this difference with amount adsorbed, were measured using the space-charge limited diode method. Information was obtained on the mobility of adatoms. Thermodynamics of the chemisorption of hydrogen on copper are discussed and it is shown that the onset of mobility necessarily leads to the desorption of molecular hydrogen. The hypothesis that the decreasing heat of adsorption with increasing coverage is related to the surface potential difference is shown to be invalid for these systems.

Adsorption

Interactions Between Molecules Adsorbed on a Surface. O. Sinanoglu and K. S. Pitzer. *J. Chem. Phys. 32,* 1279 (1960) May (10 pp.)

Two-molecule-surface potential is derived from quantum mechanical third-order perturbation theory. It is shown that this potential consists of two parts just as the energy giving the van der Waals attraction of a single molecule to a surface does. The first part exists only when the surface has a net electrostatic field and this is equivalent to the classical polarization effect. The second part arises from the fluctuations of the surface fields and is of the same origin as the dispersion forces. The third-order energy, i.e., the new intermolecular interaction caused by the surface, is directly related to the zero-coverage heat of adsorption and except for this experimental quantity, the results do not require specific assumptions about the surface.

Chemisorption

Kinetics of Chemisorption of Gases on Solids. M. J. D. Low. *Chem. Rev. 60,* 267 (1960) June (46 pp.)

Author has adopted the Elovich equation for present use in order to express, compare, and contrast with precision the otherwise chaotic data of chemisorption kinetics. Only primary direct data on chemisorption kinetics were considered, and reduction of such data to a unified set of rate parameters has frequently been replotted and recalculated. Mainly adsorptions on bulk adsorbents are considered. The following topics are discussed in greater detail: general kinetic characteristics; effects of pressure, temperature and preadsorbed gas; simultaneous and autocatalytic adsorption; the isotope effect; action of extraneous energy; carbon adsorbents; activation energy; mechanisms and equations. A total of 342 references is included.

Diffusion

Application of Diffusion Cells to the Production of Known Concentrations of Gaseous Hydrocarbons. A. P. Altshuller and I. R. Cohen. *Anal. Chem. 32,* 802 (1960) June (9 pp.)

Diffusion coefficients were determined for 2-methyl-1.3-butadiene, hexane, 1-hexene, heptane, 1-octene, decane, benzene and toluene. Diffusion coefficients at a number of temperatures were determined for hexane, 1-hexene, heptane, 1-octene, decane and benzene. Effect of turbulence at the end of the diffusion tube, resulting from rapid flow of carrier gas, was investigated as a function of gas flow rate, temperature, diffusion tube diameter and tube length. These results should aid in defining the experimental limits within which a diffusion tube apparatus may be operated so that calculated values of diffusion rate can be used, if one experimental value is available for the liquid compound of interest.

Coefficients of Evaporation and Condensation. J. P. Hirth and G. M. Pound. *J. Phys. Chem. 64,* 619 (1960) May (8 pp.)

Model is developed for crystal growth and evaporation which invokes the Kossel concept of a crystal surface being composed of low index facets, of low binding energy for adsorbed atoms, separated by ledges of higher binding energy. The treatment indicates that surface diffusion kinetics are important in most instances of crystal growth and evaporation. Prior kinetic treatments, such as those involving limitations of crystal growth because of entropy effects or diffusion in the vapor phase, are modified to include surface diffusion effects. Values for evaporation and condensation coefficient predicted by the kinetic treatment are compared with experimentally determined values.

Measurements of Multicomponent Diffusion Coefficients for the CO_2—He—N_2 System Using the Point Source Technique. R. E. Walker, N. deHaas and A. A. Westenberg. *J. Chem. Phys. 32,* 1314 (1960) May (3 pp.)

Measurements of the diffusion coefficient for a trace of carbon dioxide in a mixture of helium and nitrogen of varying composition have been made at room temperature and atmospheric pressure using the point source technique. The results are shown to be in agreement with the results of Fairbanks and Wilke in that an equation can be used to relate the diffusion coefficient of a trace of species i in a mixture of composition given by the mole fraction x_k to the binary diffusion coefficients D_{ik}. Some data are presented on the separation of the mixture in the diffusion zone.

Processing Industrial Gas Streams at High Pressures. Diffusion of Hydrogen through Palladium Membranes. A. J. deRosset. *Ind. Eng. Chem. 52,* 525 (1960) June (4 pp.)

Ability of palladium to pass hydrogen selectively offers possibilities for large-scale separation of hydrogen from process gas streams. High pressure diffusion data are, however, desirable for process design of such operations. From 50 to 700 psig at 850°F, hydrogen is diffused through an 0.0008-in. palladium membrane at a rate proportional to the difference of the 0.8 power of upstream and downstream pressures. Pressure dependency is similar to that of hydrogen solubility and Fick's law of diffusion appears to control rate. Below 20 psig diffusion is linear with pressure drop, indicating that a surface reaction is controlling. Equations are developed relating diffusion rate to pressures, feed composition and withdrawal of nondiffusible components. These can be used for analysis of specific hydrogen separation and purification problems.

The Theory of Diffusion Controlled Absorption Kinetics with Accompanying Evaporation. R. S. Hansen. *J. Phys. Chem. 64,* 637 (1960) May (5 pp.)

Quantitative theory is developed for diffusion controlled adsorption at the liquid-air interface with simultaneous diffusion-controlled loss of solute into the vapor phase. A power series representation of the adsorption valid at small times and an asymptotic representation valid at large times are given, and the integral equation is solved for adsorbates satisfying the Langmuir adsorption isotherm. The results explain the transient steady state observed recently by Hommelen in the surface tension of aqueous solutions of organic solutes.

Equilibria

The Liquid-Vapor Equilibrium of the System Nitrogen+ Oxygen at Pressures Up to 10 atm. F. Din. *Trans. Faraday Soc. 56,* 668 (1960) May (14 pp.)

Liquid-vapor equilibrium of the system nitrogen+ oxygen was determined over a complete range of composition and a pressure range of 1 to 10 atm, with a full analysis of experimental results. The static method was used in which a sample of vapor above a liquid of known composition was withdrawn very slowly for analysis under conditions of closely controlled temperature and pressure. Final accuracy claimed is 0.1°K and 0.1% in composition.

Fluid Flow

Critical Velocity of Gas. A. P. Buthod and C. Tien. *Can. J. Chem. Eng. 38,* 74 (1960) June (4 pp.)

Expression of critical velocity, based on thermodynamic consideration, was obtained. Numerical values were computed and are presented on the generalized plot basis. Together with the value of heat capacity, this method enables the rapid calculation of critical velocity of real gas when the deviation from ideal gas behavior is significant.

Equation for the Vertical Motions of Particles in Linear and Quadratic Regimes of Resistance. Y. P. Korotaev. *Trudi Vses. N.-i Prirodn. Gazov. 2,* 78 (1958) (14 pp.); *Ref. Zh. Mekh. 1,* (1959) Rev. 595; (From *Appl. Mech. Rev. 13,* 379 (1960) May.)

Investigation of the equation of motion of a heavy particle in a vertical flow of gas is given, while taking account of the resistance in the form of the sum of two terms: linear and quadratic. In case of steady motion, formulas are obtained for the velocity of particles of various sizes relative to the gas which are suitable for linear and quadratic regimes. Solution of the equation for unsteady motion of a particle relative to a uniformly moving gas results in a formula expressing damping of the velocity of particles with time in a general form.

Expansion of a Rarefied Gas Cloud Into a Vacuum. P. Molmud. *Phys. Fluids 3,* 362 (1960) May-June (5 pp.)

Analytical solutions are obtained describing the expansion into a vacuum of gas clouds having simple initial configurations. The assumptions employed are free molecular flow and local Maxwellian distribution of velocities initially. By means of a simple transformation in time, equivalence is shown between these solutions and the solutions of some elementary problems in transient heat flow. The initially uniform spherical gas cloud expanding into a vacuum is solved by two methods: 1) by the assumption of free molecular flow; and 2) by programming the conventional equations of gas dynamics.

Heat Transfer

Heat Transfer in Dissociated Combustion Gases. J. C. Cutting, J. A. Fay, W. T. Hogan and W. C. Moffatt. *AFOSR TR 59-78* (Mass. Inst. Tech., Dept. Mech. Eng.) 59 (1959) July (44 pp.); (From *Appl. Mech. Rev. 13,* 369 (1960) May.)

Report on a series of experiments and theoretical calculations to determine heat-transfer rate from the hot gas behind a detonation wave. A constant current fine wire (platinum or tungsten) heat-transfer gage was placed normal to the 1½-in. diameter shock tube walls and was swept by detonations in stoichiometric $H_2 - O_2$ mixtures at various initial pressures and in $C_2H_2 - O_2$ mixtures of differing compositions at 1 atm pressure. The effect of a thin surface coating of iodine was also assessed. The theoretical treatment is based on stagnation point heat-transfer theory and uses calculated transport properties at the gage with the assumption of a noncatalytic gage. Good agreement was found in pressure and concentration dependence of heat transfer.

Radiant Interchange Within an Enclosure. J. T. Bevans and R. V. Dunkle. Part 1. *J. Heat Transfer 82,* 1 (1960) Feb. (7 pp.); Part 2. *Ibid.,* 8 (1960) Feb. (7 pp.); Part 3. *Ibid.,* 14 (1960) Feb. (6 pp.)

The first part of this paper relates to a general analysis of radiant interchange within an enclosure filled with an absorbing and emitting medium, i.e., combustion products. The problem is approached by reviewing the basic physics of absorption (or emission) of thermal radiation by gases. Band approximations are examined and compared with experimental results. Inapplicability

of the exponential absorption law on a band energy or total energy basis is briefly discussed and deviations from experiment pointed out. In Part 2, the network method of Oppenheim is used to derive the basic network relationships between one node and the other nodes of an enclosure. This is first done on a monochromatic basis and then reduced to band energy approximation using previous results. The gray radiation approximation is shown to be one of lesser accuracy. A reiterative method of solving the network node equations for as many nodes as deemed practicable is presented in Part 3 and specific solutions are given as examples.

Stationary Temperature Distribution in the Walls of Laminated Pipe Lines. V. Vodicka. *J. Phys. Soc. Japan 14,* 959 (1959) July (6 pp. German text) (From *Appl. Mech. Rev. 13,* 365 (1960) May.)

In mathematical terms the author's problem consists of solving Laplace's equation in cylindrical coordinates with due regard for the boundary conditions. Appropriate methods of solution by Fourier expansion are well known. Solutions corresponding to given temperature distributions on the outer and inner surface of the tubes are obtained. They correspond also to the correct boundary conditions at the inter-laminar surfaces; alternative solutions are obtained satisfying a simplified inter-laminar boundary condition.

Unsteady-State Heat Transfer. S. H. Davis, Jr. and W. W. Akers. Part 1. *Chem. Eng. 67,* 187 (1960) April 18 (5 pp.); Part 2. *Ibid.,* 151 (1960) May 16 (5 pp.)

Knowledge of unsteady-state heat transfer is now a necessity for the thermal design engineer. Problems that require this knowledge include the start-up behavior of heat exchangers, reactors or similar equipment; and the response of such equipment to changes in operating conditions. Examples illustrate the basic techniques for handling such systems in which the temperature is a function of time and not position. In Part 2 consideration is given to the solid phase where the temperature is position dependent. Examples illustrate temperature distribution in walls and tubes of heat exchangers as well as heat losses of a fluid system from solids in cyclic operations.

Hydrocarbons

Applied Hydrocarbon Thermodynamics. Part 17. W. D. Edmister. *Petrol. Refiner 39,* 207 (1960) May (6 pp.)

Calculations presented all use vapor-liquid K values and relative volatilities. Improved K values by new nomographs for relative volatility, α, and K_{350}, the vapor-liquid K value for the 350°F boiling point component, are given. A description and illustration of a method for finding K values from the observed temperature-boiling-point (TBP) curves of the equilibrium vapor and liquid from experimental flash vaporization of a petroleum fraction is also presented.

Methane

The Decomposition of Methane by Low-Energy Electrons. J. E. Manton and A. W. Tickner. *Can. J. Chem. 38,* 858 (1960) June (11 pp.)

Decomposition of methane by a beam of electrons having energies between 15 and 100 ev were studied using methane pressures between 10^{-2} and 10^{-3} mm of Hg. Products were frozen out on a surface cooled to about −220°C and situated approximately 5 mm from the electron beam. Ethane, ethylene and acetylene were found to be the main products along with smaller amounts of saturated and unsaturated higher hydrocarbons. Results provide some evidence that ions do not play a major part in the decomposition and a free radical mechanism was proposed to explain the formation of the main products.

The Mercury-Sensitized Radiolysis and Photolysis of Methane. G. J. Mains and A. S. Newton. *J. Phys. Chem. 64,* 511 (1960) April (2 pp.)

Radiolysis of methane in the presence and absence of mercury at 260°C was investigated. The photolysis products must of necessity be described by processes not involving ions. The product distributions in the radiolysis and photolysis are quite similar. Mercury vapor, expected to behave as an ion-scavenger and free radical promoter, did not affect the nature or essential distribution of products. Therefore it was concluded that ion molecule reactions are not necessary to account for radiolysis of methane at 260°C.

Porosity

Determination of Effective Capillary Pressures for Porous Media from Imbibition Data. L. L. Handy. *Petrol. Trans. 219,* (Tech. Paper 8109) 75 (1960; 6 pp.)

Two equations are compared for calculating imbibition rates of water into porous media. A linear relation was found to apply when the square of the volume of water imbibed was plotted against time for water imbibing in natural rock materials. The effect of absorbed organic materials on surface wettability was determined from measurements of rate of imbibition, water saturation and water permeability.

Shock Waves

The Dissociation of a Pure Diatomic Gas Behind a Strong Normal Shock Wave. G. Jarre. *AFOSR TN 58-7; Lab. Meccanica Applicata Politecn. Torino, TN 3, ASTIA AD 1 48 046* (1957) Nov. (18 pp.); (From *Appl. Mech. Rev. 13,* 352 (1960) May.)

Equilibrium state of a pure dissociating diatomic gas behind a strong shock is discussed. A simplified model, in which the vibration of the molecules is supposed to be only half-excited, leads to results which are the same as those obtained by Lighthill. Dissociation rate in the nonequilibrium region is examined. Estimates of length of the relaxation zone are made by assuming the reaction to be isenthalpic and the length to be controlled by the final approach to equilibrium.

The Structure of Weak Shock Waves in Real Gases. A. Szaniawski. *Arch. Mech. Stos. 11,* 173 (1959) Feb. (20 pp.); (From *Appl. Mech. Rev. 13,* 352 (1960) May.)

Starting point of these considerations is a critical analysis of the existing methods for calculating thickness of the shock wave; experimental results show that

for the majority of real gases the thickness of the shock wave is greater than the calculated value. The cause of this discrepancy is attributed to the fact that the relaxation phenomenon is not taken into account (relaxation time—time necessary for attaining thermodynamic equilibrium). An equation for the thickness of a weak shock wave is given. From this equation it is concluded that the influence of the second virial coefficient in the equation of state, the Prandtl number, and the volume viscosity on the wave thickness is insignificant.

Thermal Conductivity

Thermal Conductivities of Rare Gas Mixtures. E. A. Mason and H. von Ubisch. *Phys. Fluids 3,* 355 (1960) May-June (7 pp.)

Recent measurements of thermal conductivities of all ten possible binary mixtures of the rare gases and of the ternary mixture He-Kr-Xe at 29°C are compared with theoretical calculations. Three calculations are carried out, based on: 1) rigorous kinetic theory, 2) an approximate formula which uses only conductivities of the pure components, and 3) a new semiempirical formula which also requires knowledge of the conductivity of one composition of binary mixture. The agreement is generally satisfactory and furnishes support for the usefulness and accuracy of the formulas used.

The Initial Pressure Dependence of Thermal Conductivity and Viscosity. D. E. Stogryn and J. O. Hirschfelder. *Univ. Wisconsin, Naval Research Lab., Dept. Chem. WIS-ONR-36* (1959) April (34 pp.); (From *Appl. Mech. Rev. 13,* 365 (1960) May.)

Both thermal conductivity and viscosity of real gases depend on pressure and may be expressed as power series in pressure. Calculated are the first-order terms in such an expansion by assuming spherically symmetric interaction potentials, considering the two effects of molecular association and collisional transfer. Previous work is discussed. A comparison of present theory with experiment shows good agreement.

Investigation in Connection with Nonlinear Heat Conduction. S. Borbely. *Magyar Tud. Akad. Musz. Tud. Oszt. Kozl. 23,* 261 (1959) March-April (26 pp. Hungarian text); (From *Appl. Mech. Rev. 13,* 365 (1960) May.)

Account of computational and experimental work on transient temperature distributions in heated cylinders is given. Nonlinearity of the problem arises from the strong temperature-dependence of physical properties. A wide discrepancy between calculated and observed temperature distributions leads the author to infer that the conventional definition of thermal conductivity may be inadequate for study of unsteady-state processes.

Measurement of the Thermal Conductivities of Gases at High Temperatures. R. G. Vines. *J. Heat Transfer 82,* 48 (1960) Feb. (5 pp.)

Experimental results are reported for thermal conductivities of air, argon, nitrogen and carbon dioxide at temperatures up to 900°C and of steam up to 560°C. These results are compared with values predicted from correlation formulas based on low-temperature measurements.

Numerical Solutions to an Inverse Problem of Heat Conduction for Simple Shapes. G. Stolz, Jr. *J. Heat Transfer 82,* 20 (1960) Feb. (7 pp.)

Numerical methods are presented for solving an inverse problem of heat conduction: with a given interior temperature vs. time, the surface heat flux vs. time is to be found. The analysis is developed specifically for spheres; it applies to other simple shapes. The system is treated as linear, permitting use of the superposition principle. Care is required in selecting a time spacing for, if it is chosen too small in relation to the conditions, undesirable oscillation results.

Thermal Conductivity of Helium and Hydrogen at High Temperatures. N. C. Blais and J. B. Mann. *J. Chem. Phys. 32,* 1459 (1960) May (7 pp.)

Steady-state hot wire method for measuring thermal conductivity of light gases in the temperature range 1200°-2100°K is described. In contrast to other methods, free convection currents and large temperature gradients occur; convection effects are shown to be negligible, and the experimental procedure for eliminating the large gradient effects is described. Equations for the thermal conductivity of helium and hydrogen are developed for the covered temperature range.

Thermodynamics

Approximations for the Thermodynamic and Transport Properties of High-Temperature Air. C. F. Hansen. *Tech. Report R-50.* (Washington: Nat. Aero. and Space Admin., 1959, $.35)

Approximations are presented for the thermodynamic and transport properties of high-temperature air. Compressibility, enthalpy, entropy, specific heats, the speed of sound, the coefficients of viscosity and thermal conductivity, and the Prandtl number for air are tabulated from 500° to 15,000° K over a range of pressures from 0.0001 to 100 atmospheres.

Thermoelectricity

Contribution to the Experimental Determination of Thermoelectric Effects of Semiconductors. U. Birkholz. *Solid-State Electronics, 1,* 34 (1960) March (5 pp.)

The technical use of the thermoelectric effects has been practicable for some years, since the development of special semiconductors. The efficiency of thermoelectric generators, as well as the coefficient performance of Peltier refrigerators and the coefficient for reversible heating, are determined by the same material constant, the figure of merit z. This magnitude is obtained by the square of the absolute thermoelectric power α, multiplied by the electric conductivity σ and divided by the thermal conductivity κ. In the following paper a method is described by means of which α, σ and κ are ascertainable in the range of room temperature by use of a single piece of apparatus; errors of measurement arising by heat radiation, as well as inhomogeneity of the samples, are discussed.

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